Compressed Air Magazine

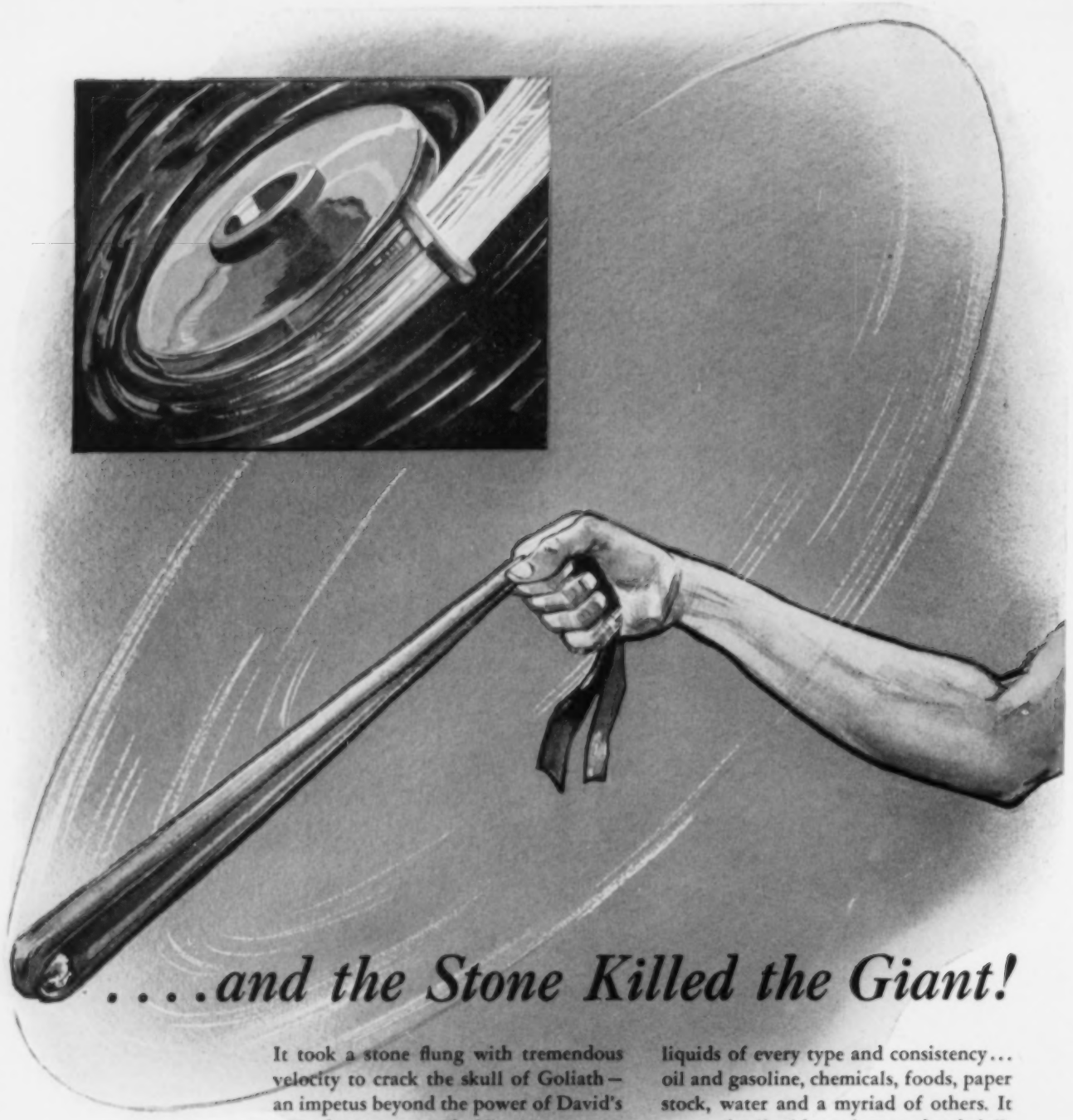
DECEMBER 1944

BURLINGTON AIR BRAKE TRIALS

Artist's conception of scene in Iowa during epochal tests of 1887.

VOLUME 49 • NUMBER 12

NEW YORK • LONDON



....and the Stone Killed the Giant!

It took a stone flung with tremendous velocity to crack the skull of Goliath—an impetus beyond the power of David's puny, human strength. His conquest was made possible by a harmless-looking slingshot...a primitive weapon which derived its potency from centrifugal force.

This same age-old principle, its effectiveness multiplied by the miracle of modern engineering, is embodied in the centrifugal pump...a highly efficient machine universally used in the transportation of vital liquids. It handles liquids of every type and consistency... oil and gasoline, chemicals, foods, paper stock, water and a myriad of others. It serves the liquid-moving needs of civilization on land, in deep mines, aboard ship and on airplanes. Few other machines bear such a responsibility so capably.

Ingersoll-Rand engineers are pump specialists. Their years of experience in applying centrifugal pumps to industries of every description are at your disposal. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, New York.

Ingersoll-Rand

10-487

CENTRIFUGAL PUMPS • CONDENSERS • COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES

More than a "Separator"

PROTECTOMOTOR PIPE LINE FILTER DELIVERS *Clean* AS WELL AS *Dry* AIR

Rust, Pipe Scale, Dirt and Dust removed in addition to Water and Oil

Repeat orders from hundreds of leading American concerns prove that Protectomotor Pipe Line Filters save money, speed production. Easy and quick to install, Protectomotors have often saved their entire cost in a single month.

Find out how in your operation Protectomotors will increase output, help win the war.

WRITE FOR CATALOG

DOLLINGER CORPORATION

(Formerly STAYNEW FILTER CORP.)
7 CENTRE PK. ROCHESTER 4, N. Y.

Air Filter Headquarters

FILTERS FOR PIPE LINE, ENGINE INTAKE AND BUILDING VENTILATION

Temperature Changes Mean Trouble in Unprotected Air Lines

Moisture in compressed air is condensed as the air passes through cold sections of pipe. Unless removed, this water washes out lubrication from air-powered tools, freezes upon expansion in these tools, and causes loss of power or stoppage due to clogging of ports; causes delays and waste at other points of compressed air usage. Staynew Pipe Line Filters (Protectomotors), installed as near point of use as possible, remove water and oil, preventing these troubles.

Model CPH

Double Action ★ Exclusive Construction

Air or gas strikes deflector (2), and is impinged against sides of housing (1). Oil, water, and heavy dirt particles drop to bottom and are drawn off thru drain (5). Fine dirt particles are removed from air or gas by positive action of the dry-type filtering medium which covers the patented Radial Fin Insert (4). Louvred housing (3) evenly distributes air or gas over surface of insert.

STAYNEW PROTECTOMOTOR FILTERS

TO WEATHER POST WAR *UNCERTAINTY*

Naturally you want to establish yourself quickly and permanently in the post war era. To help you, Blaw-Knox offers engineering and products of wide range. It also has the facilities and personnel to manufacture for you, all or parts of your products.

One of the most important activities at Blaw-Knox is the Process Equipment Department, which among other things, specializes in the design and manufacture of equipment for the carrying out of chemical reactions by both the batch and continuous processes. This department is fully qualified to render a complete service from building pilot plants to equipment for full scale production.

Blaw-Knox leadership in the origination and fabrication of products for so many fields of industry is a ground for confidence that it can be of help to you if your business comes within the scope of its activities. Many Blaw-Knox products now of international reputation were originated to fill the needs of one manufacturer. Perhaps the Blaw-Knox umbrella of industrial coverage can include worth while services to you. May we talk it over?

A chemical plant designed, fabricated and erected by Blaw-Knox for large midwest manufacturer.

BLAW-KNOX COMPANY

A Pacemaker for American Initiative and Ingenuity

2023 Farmers Bank Bldg., Pittsburgh, Pa.

Buy More War Bonds and Stamps

LEWIS FOUNDRY & MACHINE DIVISION, Rolls and Rolling Mill Machinery

NATIONAL ALLOY STEEL DIVISION, Heat and Corrosion-Resistant Alloy Castings

SPECIAL ORDNANCE DIVISION, Bofors Anti-Aircraft Gun Mounts and Mechanisms

PITTSBURGH ROLLS DIVISION, Rolls for Steel and Non-Ferrous Rolling Mills

POWER PIPING DIVISION, Prefabricated Piping Systems

BLAW-KNOX DIVISION, Chemical & Process Plants & Equipment, Construction Equipment, Steel Plant Equipment, Radio & Transmission Towers . . . General Industrial Products

COLUMBUS DIVISION, Ordnance Matériel

UNION STEEL CASTINGS DIVISION, Steel and Alloy Castings

MARTINS FERRY DIVISION, Bofors Anti-Aircraft Gun Mounts

BLAW-KNOX SPRINKLER DIVISION, Automatic Sprinklers and Deluge Systems

Five Blaw-Knox Plants have been awarded the Army-Navy "E" for war-production excellence

A FEW VICTORY PRODUCTS

ANTI-AIRCRAFT GUN MOUNTS · GUN SLIDES · LANDING BARGES · AERIAL BOMBS · POWDER PLANTS · PIPING FOR NAVAL VESSELS · SYNTHETIC RUBBER PLANTS · CAST ARMOR FOR TANKS & NAVAL CONSTRUCTION · CHEMICAL PLANTS

Successful "air aid"

COMPRESSED AIR aids production in scores of vital ways. Not so vital, perhaps, but certainly a big help in saving time and energy is the ingenious invention pictured . . . a broom with air hose attached to speed clean-ups.

Successful functioning of industry's many air-driven tools depends on efficient, trouble-free compressor operation which, in turn, depends on effective lubrication. That is why experienced operators lubricate with Texaco.

Texaco Alcaid, Algol or *Ursa Oils*, for example, assure wide-opening, tight-closing valves, free piston rings, open ports, clear lines, continuous air supply. They also assure maximum service life between overhauls, fewer repairs and replacements. Their use in air compressors is nationwide.

Texaco lubricants have proved so effective in service they are definitely preferred in many fields, a few of which are listed at the right.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States. The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ *More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.*

★ *More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

★ *More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.*

★ *More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.*

★ *More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.*

TEXACO

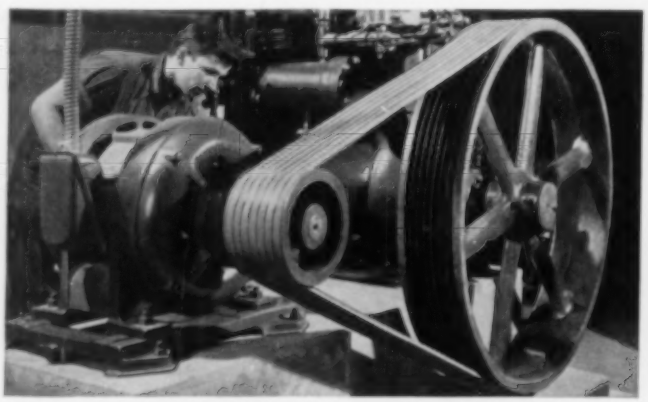
TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

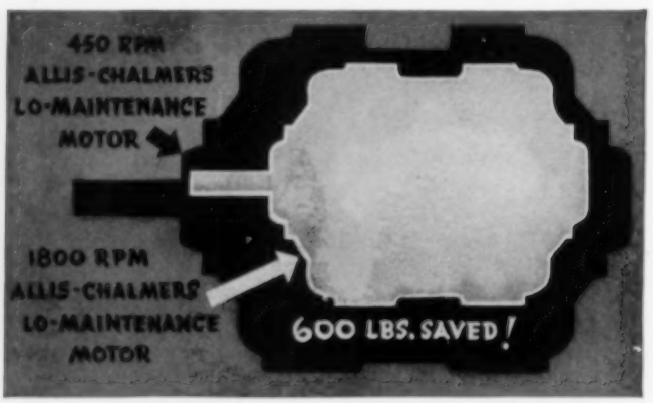
TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

It's Time to Look at Motor

➔*You Can Save with High-Speed Instead of*

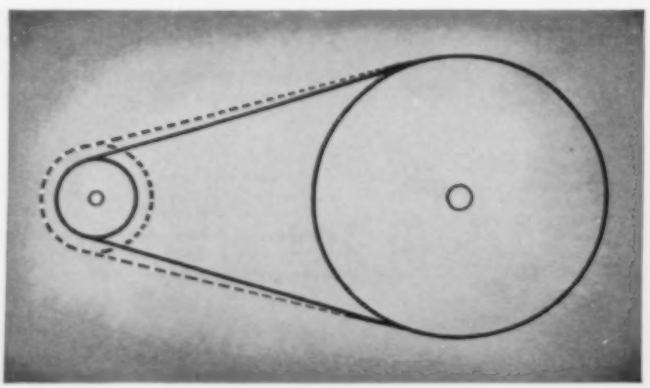


1. In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor . . . *and* give you *exactly* the speed you want — *at lower cost!*

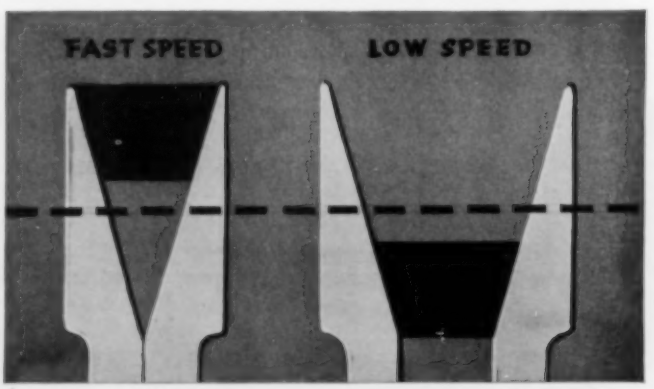


2. When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb of critical materials are saved. And *you* save well over $200—with the drive figured in! This saving is typical.

➔*You Can Save with Single-Speed Instead of*



1. Infrequently needed speed changes can be had by changing from one size motor sheave to another. By juggling *complete* drives, speeds can be changed over the full range — from 1:1 to 7:1.

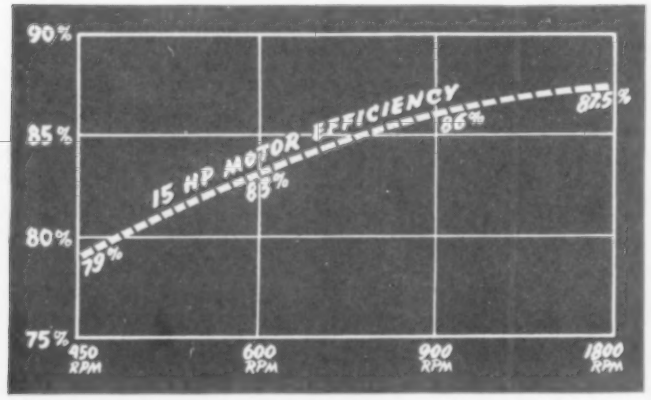


2. With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter, as above. Within limits, an unbroken series of speeds can be obtained.

Take a Fresh Buying!

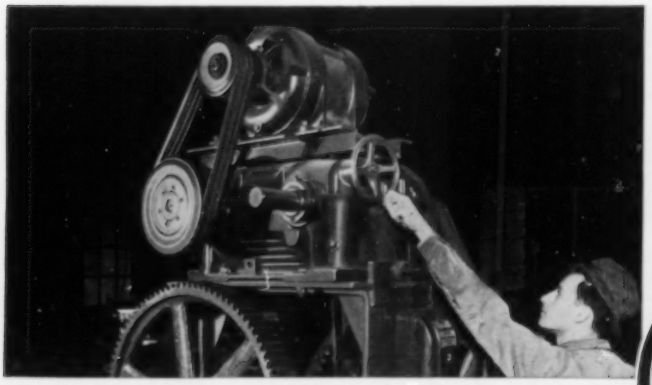
WAR FORCES HIGHER EFFICIENCIES...

Low-Speed Motors...



3. Note that efficiency rises from 79% for a 450 rpm motor to 87.5% for an 1800 rpm motor. Comparing power consumption, the 1800 rpm motor saves you over 30 kwh/24 hr. day.

Multi-Speed Motors...



3. Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's the most compact, flexible variable-speed transmission available.

It was good business in peacetime to use — as widely as possible — high-speed motors with Allis-Chalmers Texrope Drives...and single-speed motors with Allis-Chalmers Vari-Pitch Sheaves and Speed-Changers. And it's clearer every day that those material and money-saving practices are *vital* practices in time of war!

TODAY the whole picture of buying and applying motors has changed. Note at the left how much you can save for your country *and yourself* with high and single-speed motors made flexible by Texrope Drives.

As America's only builder of both electric motors and V-belt drives, Allis-Chalmers has long advocated the proper combining of motor and V-belt drive.

And today you benefit from Allis-Chalmers' vast, pioneering experience in this field when you ask for and get the *right* combination of Lo-Maintenance Motor and Texrope Drive! Call your nearby district office. Or write ALLIS-CHALMERS MFG. CO. MILWAUKEE, WISCONSIN.

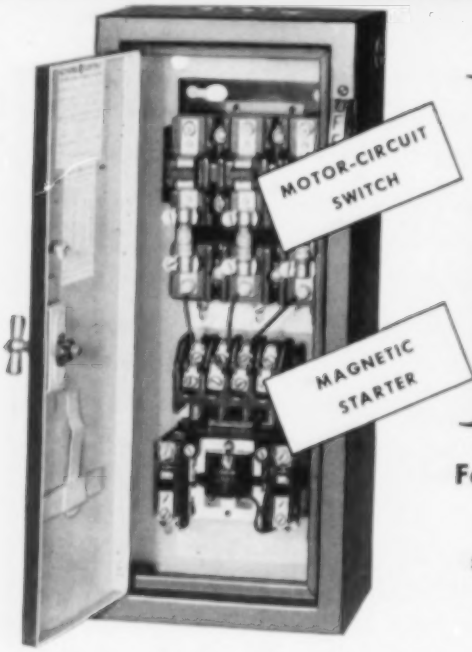
A 1560

♪ *Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, E.W.T.*

ALLIS-CHALMERS A-C MILWAUKEE

WE WORK FOR VICTORY — WE PLAN FOR PEACE

MOTOR STARTERS EVERY TYPE, EVERY KIND, FOR EVERY MACHINE APPLICATION



YOU SAVE 6 WAYS WITH COMBINATION STARTERS

For full-voltage starting of squirrel-cage a-c motors

1. **50% reduction in mounting time** — You mount only one device.
2. **40% reduction in wiring time**— Connect to only 9 terminals, not 15.
3. **Sure safety**—Cover cannot be opened while power is on the starter.
4. **Reliable motor protection**—Protection devices are co-ordinated.
5. **Saving of wall space**—The one device takes less space than two.
6. **Improved plant appearance**—Single, streamlined case; less open wiring and conduit.

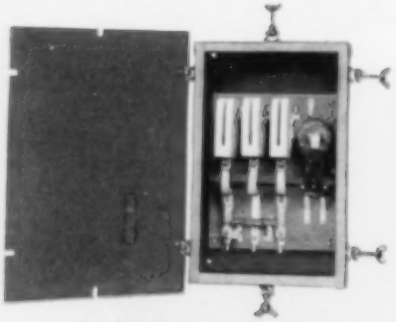
Whatever your plant's operating condition, you can get a suitable G-E combination control. This means a motor-circuit switch (with short-circuit protection) and a magnetic starter—in one compact, easy-to-mount unit.

Write today for more information about these combination starters. Our engineers will be glad to help you select just the right starter for your application. *General Electric Company, Schenectady 5, N. Y.*

General Purpose | **Water-tight** | **Dust-tight** | **Oil-Immersed**

Magnetic full-voltage starter—Showing START-STOP push button mounted in cover of a general-purpose case.

A-c magnetic starter—Wall-mounted, overload-relay reset button in cover, and push button can be added.



Fabricated case of cold-rolled sheet steel—Wall-mounted — overload-relay reset button in cover.

General-purpose starter—Suitable for use in corrosive atmospheres found in such places as chemical plants and oil refineries or for outdoor use.

Buy all the BONDS you can—and *keep all you buy*

GENERAL ELECTRIC

HOW TO SOLVE OPERATING PROBLEMS WITH *Correct Lubrication*

Stop Stoper Stalling

WITH THIS NEW OIL!

BY SPECIFYING Gargoyle Almo Oil No. 3, you can be sure that your stopehammers will stay on the job with maximum footage.

This special rock-drill oil not only forms strong films that stand up under severe loads such as imposed on rifle bars, but also resists water and oxidation. Thus, it protects the moving parts against wear and rust, maintains the piston seal and keeps valves and ratchet pawls free from gummy deposits.

Just as important to all drill operators, there are no objectionable odors, no fog or no eye-burning effects.

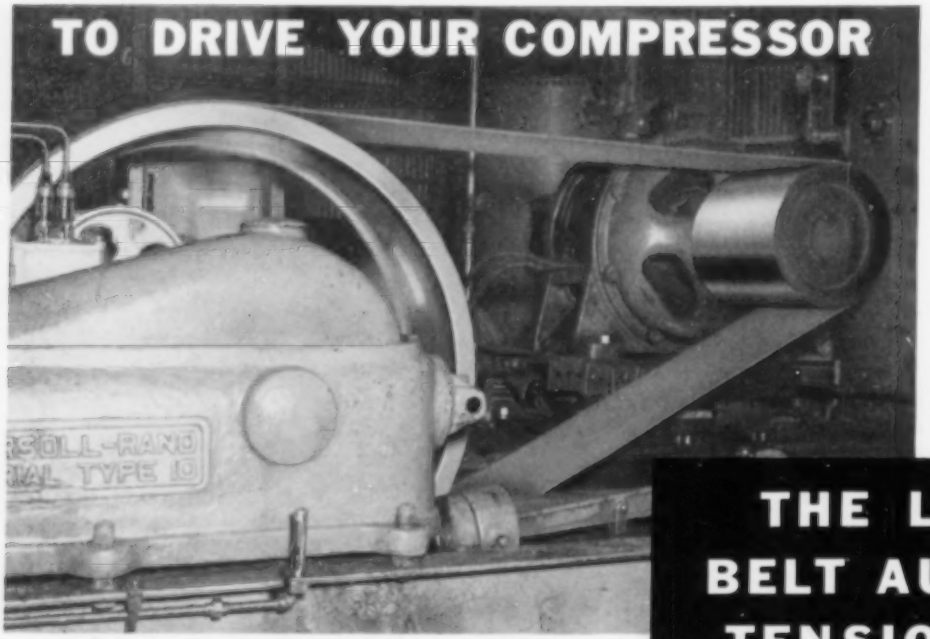
SOCONY-VACUUM OIL CO., INC.
Standard Oil of N.Y. Div. • White Star Div. Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Co. • General Petroleum Corp. of California.

GARGOYLE Lubricants

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

CALL IN SOCONY-VACUUM

The Leather Belt Automatic Tension Drive— pivoted motor base and flat leather belt— automatically varies belt tension to match the load.



USE

THE LEATHER BELT AUTOMATIC TENSION DRIVE

Here are the advantages of this type of drive:

Easy to figure—easy to install.
No guesswork about tension.
No matching of belts.
Lower initial cost.
Less space required.
Fewer belt take-ups.
Less maintenance to driving and driven equipment.
No frequent pulley replacements.
Lower power cost.

TO BELT THIS DRIVE

USE GRATON & KNIGHT "RESEARCH"

It has great pliability and high coefficient of friction.

You benefit because you get maximum pulley grip and most power transmission even with small arc of contact on pulley.

It has low stretch. Restretching removes all non-elastic stretch.

You benefit because the elasticity of Research belt absorbs shock, starting or impulse loads. Less maintenance time and cost.

Its special curry results in resistance to internal heat

Even when operated at high speed Research gives you longer, more economical belt performance.

GRATON & KNIGHT COMPANY

WORCESTER 4, GRATON AND KNIGHT MASSACHUSETTS

Branches and distributors everywhere. Look under "Graton & Knight" in "Belting" section of classified telephone directory or THOMAS' REGISTER.

- **Longer Rope Life**
- **Lower Operating Costs**
- **Low Cost Maintenance**

with

LAKE SHORE

Timken Bearing Type

HEAD SHEAVES

• Lake Shore heavy duty bicycle sheave shown above offers a combination of proven features that will provide new operating advantages and economies in your mine.

Easily replaceable steel liners reduce wear on sheave throats and rope.* Anti-friction Timken bearings further increase wire rope life by reducing overrun and underrun; bearing alignment and lubrication are simplified.

"Straight line" Toncan iron spokes assure maximum rigidity and strength. Special steel shaft. Hub serves as a lubricant reservoir and the bearings are adjustable for wear. Shaft and bearings last as long as 25 years. Take advantage of these features. Write today.

*Liners, engineered to fit the sheave, available from Lake Shore.

Write for catalog No. 446 for complete information on Lake Shore Bicycle Type Head Sheaves, standardized, lightweight Idler Sheaves and Carrying Sheaves.

Skips, Cages, Hoists, Sheaves, Cars, Grizzlies, Crushers, Conveyors, Log Washers, Snatch Blocks, Ball Mills, Accumulators, Sinking Buckets and Scrapers. Miscellaneous and Special Machinery and Equipment.

LAKE SHORE
ENGINEERING COMPANY

Iron Mountain, Michigan

Main Plant at: Marquette, Michigan
Offices at: 15 Park Row, New York 7, N. Y.
417 Market Street, San Francisco 5, Calif.
2-260 General Motors Bldg., Detroit 2, Mich.

Look to Lake Shore for Leadership

RockerShovel Stope

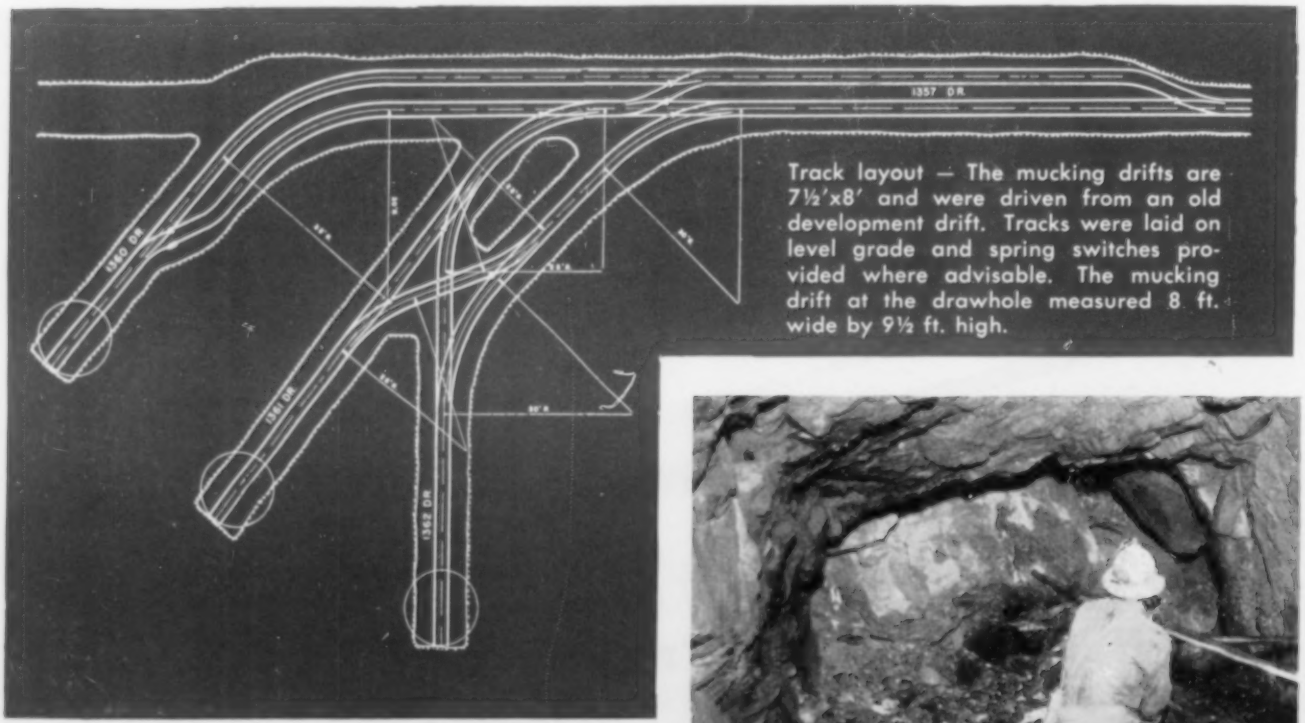
Mechanical loading out of shrinkage stopes, advocated for many years by the pioneers of the RockerShovel as an economical method of drawing ore in this type of mining, has been tried by many progressive mining men in the United States and foreign countries. Each trial has shown new advantages for those who use mechanical loading, and has convinced those who try it that, by using a mechanical loader, they have a better, cheaper method of mining.

The advantages outlined in a recent paper* by officials of Noranda Mines, Ltd., are numerous. The mechanical loader (a Model 21 Eimco RockerShovel) eliminates the old fashioned methods of grizzlies, ore pass raises, loading chutes, etc., with their inherent troubles and hazards. The RockerShovel loads large pieces, reducing block holing and secondary blasting costs.

Eimco RockerShovels are available in 4 separate and distinct sizes each with a full range of track gauges and discharge heights. Loading varies from 1 to 5 tons per minute depending on the machine model.

Eimco engineers will gladly consult with you and assist you in adapting RockerShovels to your method of mining. Write today—there is no obligation.

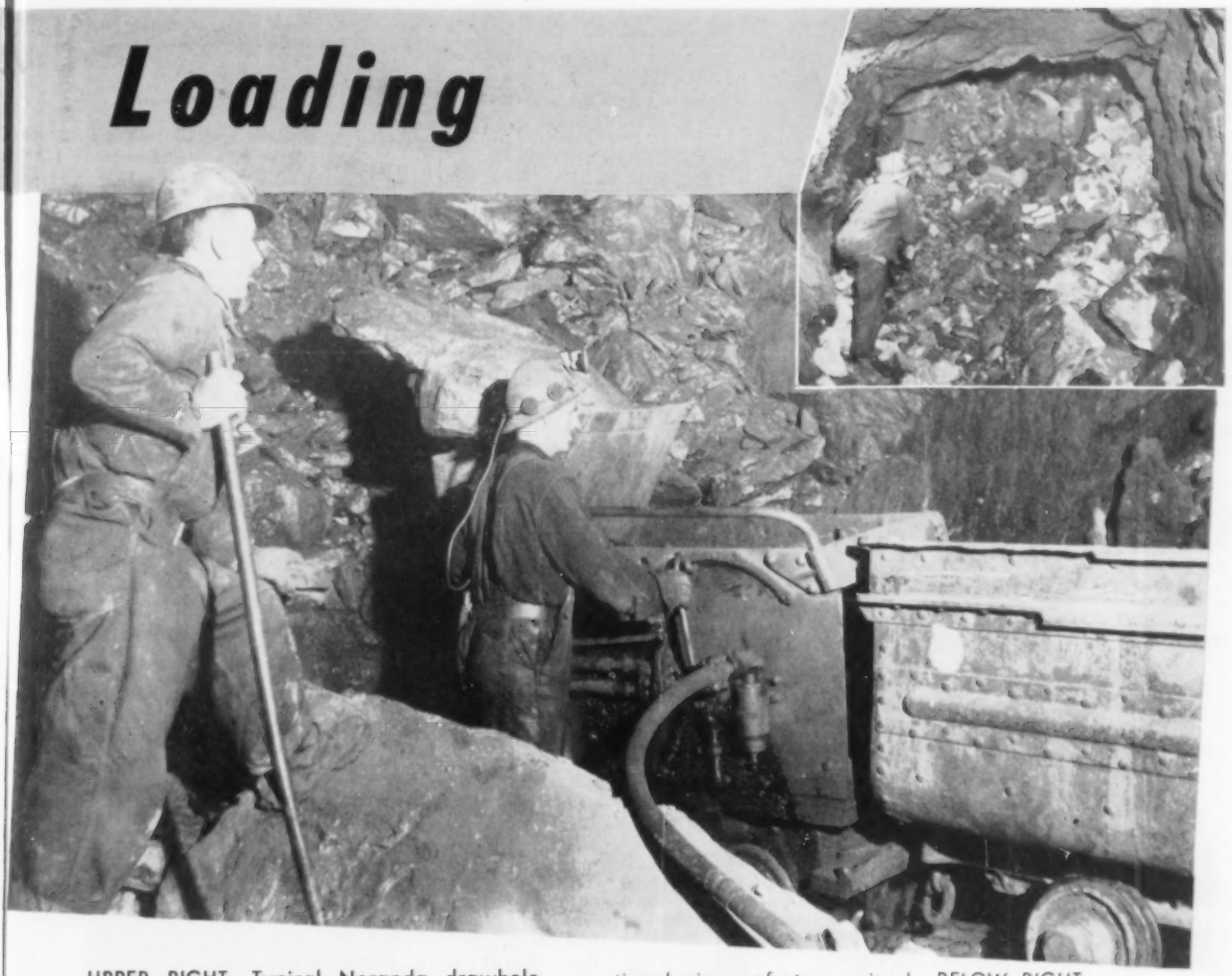
*Mechanical Loading from a Small Stope at Noranda. By J. A. Costa and N. A. Eilertsen—C. I. M. Trans., Vol. XLVII, 1944, pp. 291-301 Canadian Mining and Metallurgical Bulletin, July 1944. A reprint of this article will be furnished by Eimco on request.



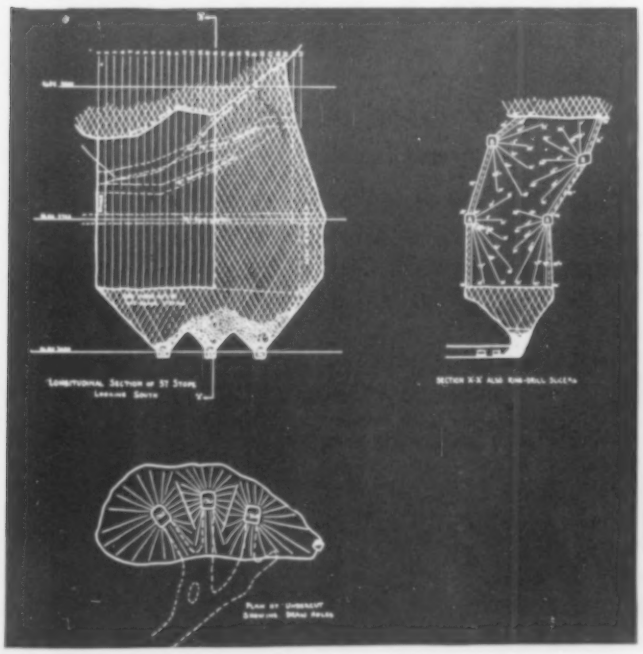
Track layout — The mucking drifts are 7½'x8' and were driven from an old development drift. Tracks were laid on level grade and spring switches provided where advisable. The mucking drift at the drawhole measured 8 ft. wide by 9½ ft. high.

Two drawholes were available for mucking for practically the whole period of mining so that the mucking crew could quickly change over from one drawhole to the other when large muck was encountered. This enabled the blockhole miner to keep ahead of the mucking machine.

Loading



UPPER RIGHT:—Typical Noranda drawhole showing broken sulphide ores. ABOVE:—Eimco Model 21 RockerShovel handles rock that would have to be blockholed before loading with hand methods. BELOW LEFT:—Plan and sectional views of stope mined. BELOW RIGHT:—The Loader is not coupled to the car but kept a short distance behind. This allows the RockerShovel to move freely which assists in loading big rock



EIMCO

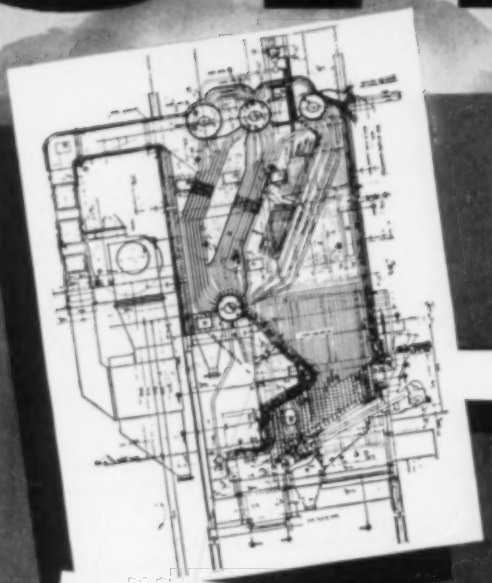
THE EIMCO CORPORATION

Executive Offices and Factories Salt Lake City 8, Utah

Branches New York, Chicago, El Paso, Sacramento, St Louis

STEAM

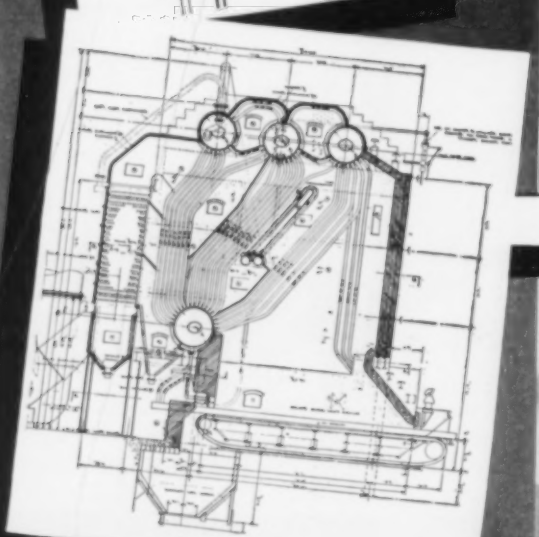
for



POWER

SOUTHERN COLORADO POWER COMPANY
Pueblo, Colo.

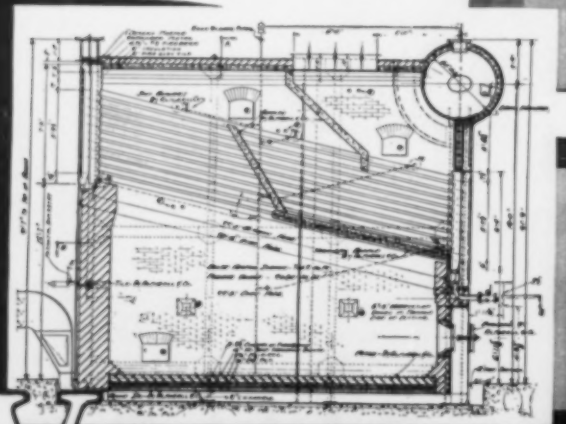
90,000 lbs. steam per hour Vogt LE type bent tube boiler with underfeed stoker. Water walls and economizer. Design pressure 525 lbs. Total steam temperature 750 degrees F.



PROCESS

IN A LARGE MID-WESTERN STEEL MILL

Two 105,000 lbs. steam per hour Vogt LE type bent tube boilers with chain grate stokers and economizers. Design pressure 225 lbs. Total steam temperature 550 degrees F.



HEATING

CRIMINAL COURTS BUILDING AND JAIL
New York City

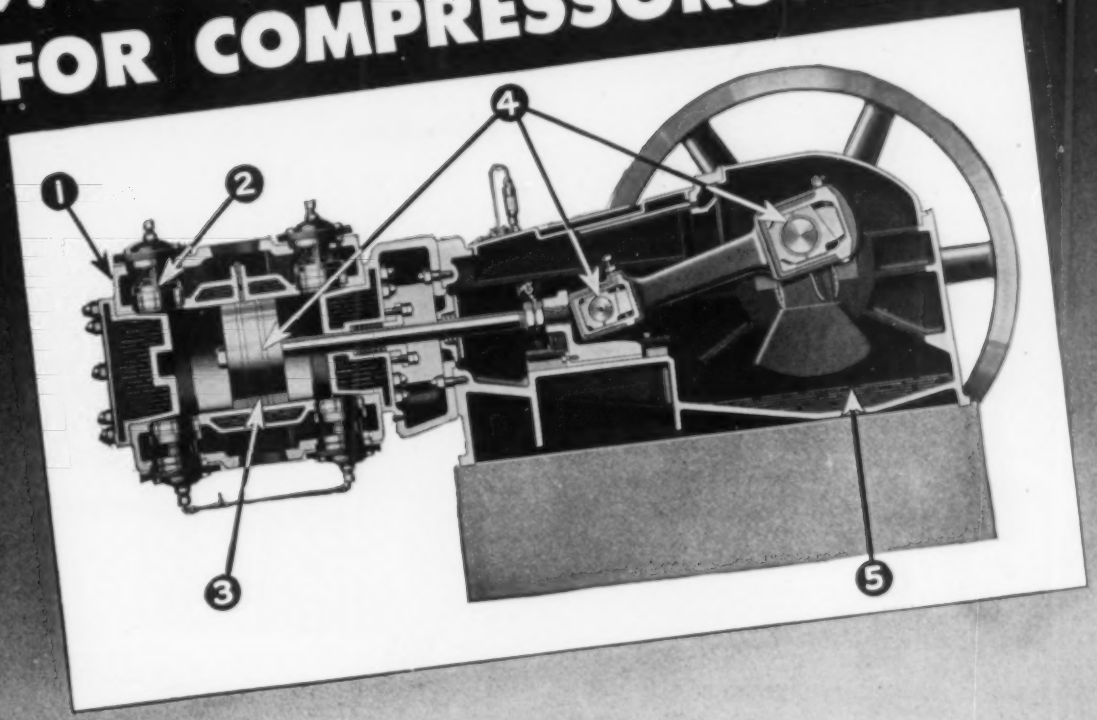
Four Vogt sectional header type boilers of 47,000 lbs. steam per hour capacity, oil fired. Design pressure 200 lbs.

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY
Branch Offices: NEW YORK CLEVELAND
CHICAGO PHILADELPHIA DALLAS

Vogt *Water Tube* BOILERS

BENT TUBE AND SECTIONAL HEADER TYPES

A "LAZY" OIL WON'T DO FOR COMPRESSORS!



IF your compressor oils are not doing *all* of the jobs listed in the box at right they're "lazy" . . . should be changed. For "lazy" oils cause excess wear of pistons and bearings, make more frequent replacements necessary. And you know how scarce replacement parts are these days . . . how long it takes to get deliveries.

Keep your compressors "on the job" with hard-working Shell Compressa Oils. They have *all* of the characteristics necessary to trouble-free compressor performance. Call in the Shell man now for the full details.

SHELL COMPRESSA OILS KEEP COMPRESSORS ON THE "GO"

1. Are highly stable under severe operating conditions . . . do not break down at high temperatures.
2. Prevent excessive carbon formation on valves.
3. Help prevent ring-sticking and blow-by . . . assure effective sealing of pistons.
4. Assure low oil consumption and reduce wear by covering all sliding and rotating parts with a tough, adherent film.
5. Have high resistance to emulsification.

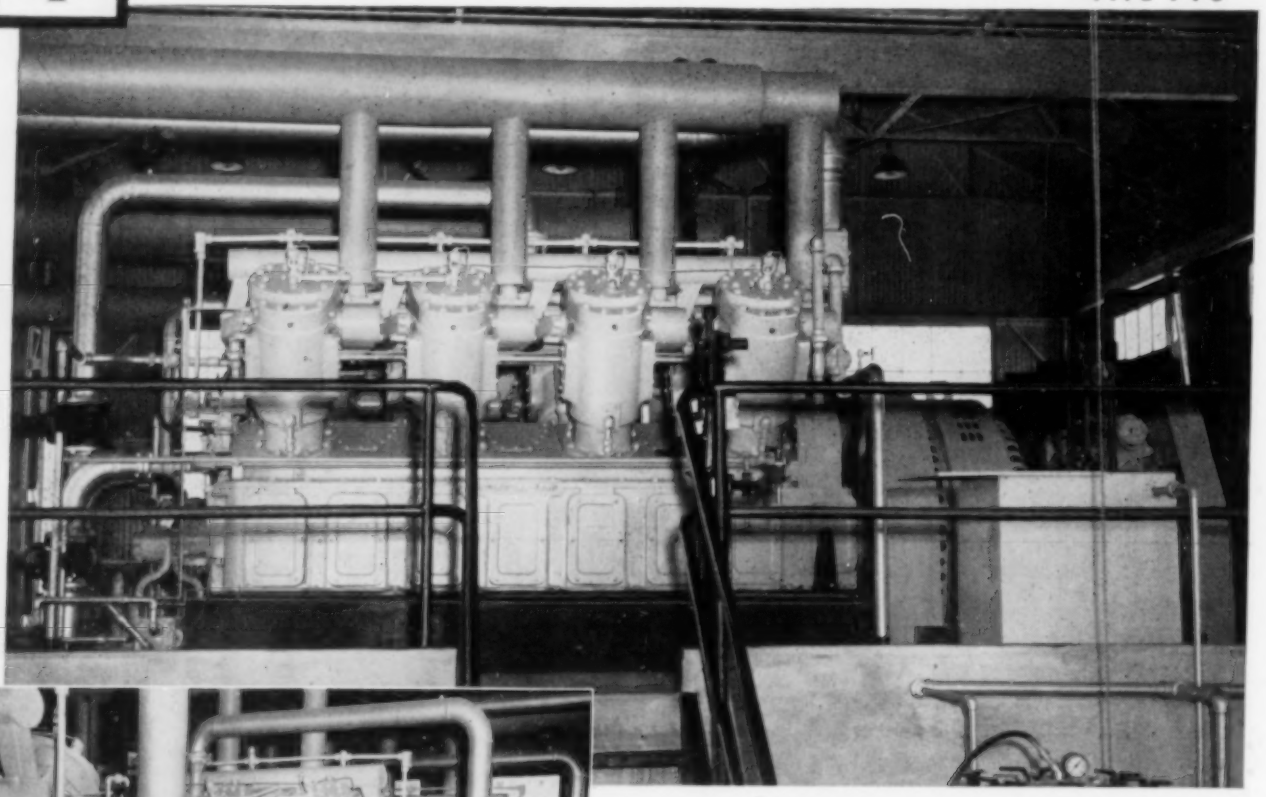
SHELL *COMPRESSED AIR* LUBRICANTS

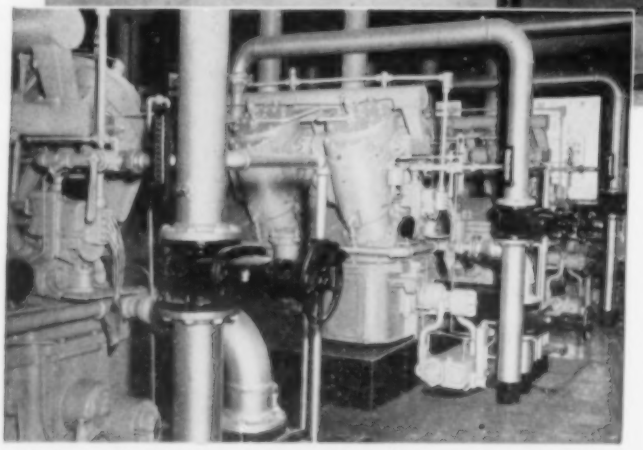
COMPRESSA OIL
FOR AIR COMPRESSORS

CLAVA OIL
FOR AIR TOOLS

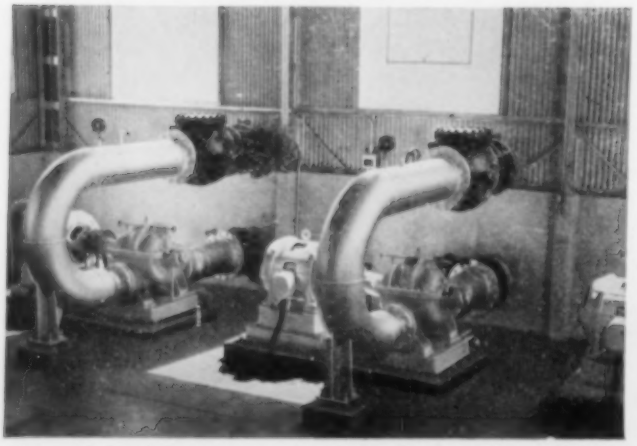
GAS ENGINE GENERATOR SETS

TYPE PVG





The Batesville station—one of four, in each of which are installed three PVG engines.



Ingersoll-Rand Cameron centrifugal circulating water pumps serve many stations on the Tennessee Gas & Transmission Line.

Serve the Tennessee Gas & Transmission Line

A number of the big stations of the great new line of the Tennessee Gas and Transmission Company are served by generators driven by Ingersoll-Rand 4-cycle Type PVG gas engines. Each installation has three 8-cylinder, 370 horsepower engines direct-connected to alternating current generators.

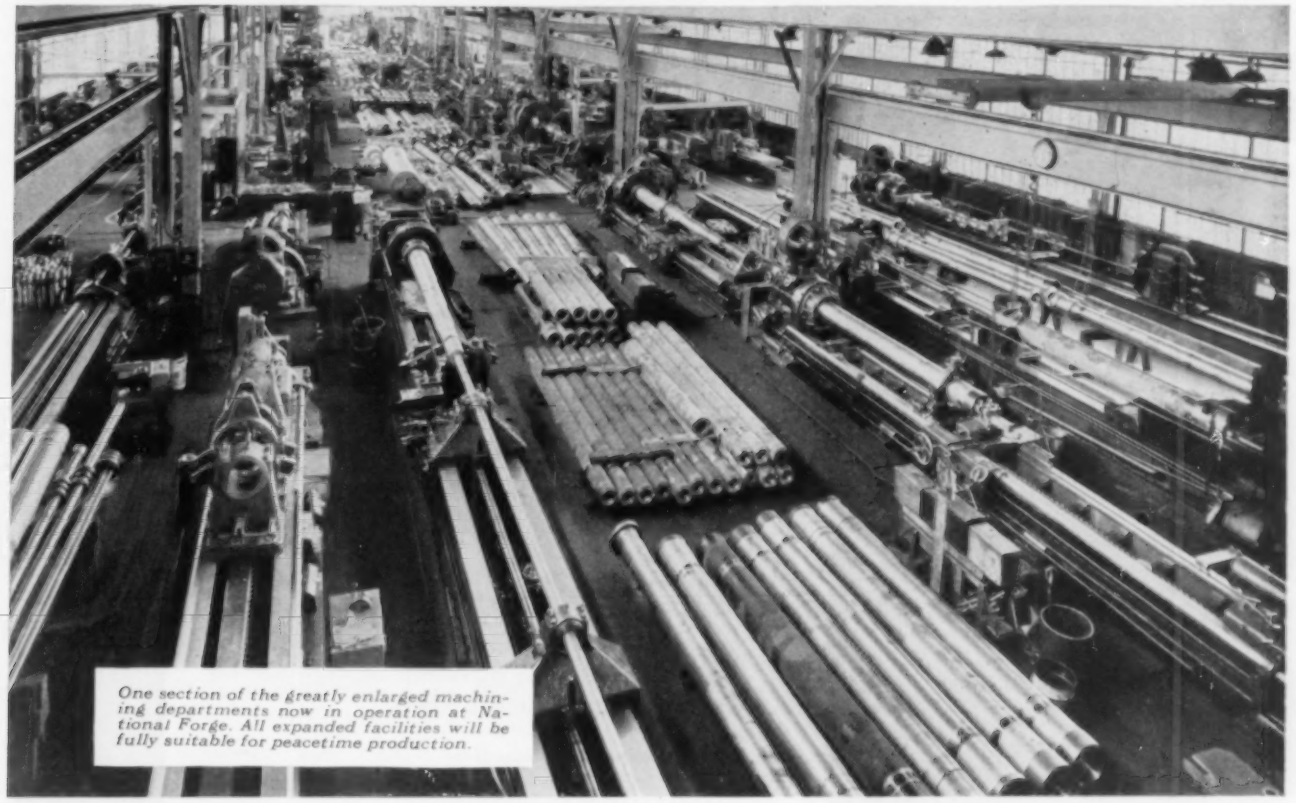
Gas engines of this type have established an enviable reputation in all divisions of the petroleum industry—pipelines, refineries, repressuring, recycling, and gasoline plants—driving generators, pumps, blowers, etc. Size 185 to 1200 BHP.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

6-560

IF THE FORGING IS HEAVY DUTY, IT SHOULD BE NATIONAL FORGED



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ON THE COVER

OUR cover picture is a reproduction of one of a series of paintings prepared by the Westinghouse Air Brake Company for the observance of the seventy-fifth anniversary of the invention of the air brake. (Three other pictures of the series are shown in our leading article). The scene is near Burlington, Iowa, where various braking devices for freight trains were tested in 1886-87. Some of them, including Westinghouse's offering, stopped the 50-car test train; but they did it with such jolting that there were actually broken arms and legs in the rear car where the observers rode. All the brakes were consequently rejected; but after the trials were over, Westinghouse developed improved equipment that was ultimately adopted by all the nation's rail lines.

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IN THIS ISSUE

OUR first article tells the story of the air brake, which, as is pointed out on the editorial page, was the forerunner of the multitude of pneumatic applications made since then in the United States.

•

THERE are said to be some six million kinds of insects, and no Victory gardener will dispute the estimate. For each harmful insect, Nature provides a parasite to keep it in check; and if the proper parasites can be found and liberated near their hosts, or foes, man will get a fair share of the crops he plants. R. G. Skerrett describes how entomologists seek them out in the far corners of the earth, bring them here, and put them to work.

•

THE pneumatic tire will be 100 years old in 1945. It is of British origin, having been invented in Scotland before there was a real need for it and "reinvented" in Ireland when the bicycle began to grow popular. Its early development is traced in *Some Pneumatic Tire History*.

•

FROM far-off Burma comes a 1-page article by Michael M. Harris of the Army's Services of Supplies that tells how American machinery is aiding Chinese coolies in reopening the back road to Tokyo as fast as the Japs can be pushed back. Varied applications of compressed air are presented in two pages of pictures.

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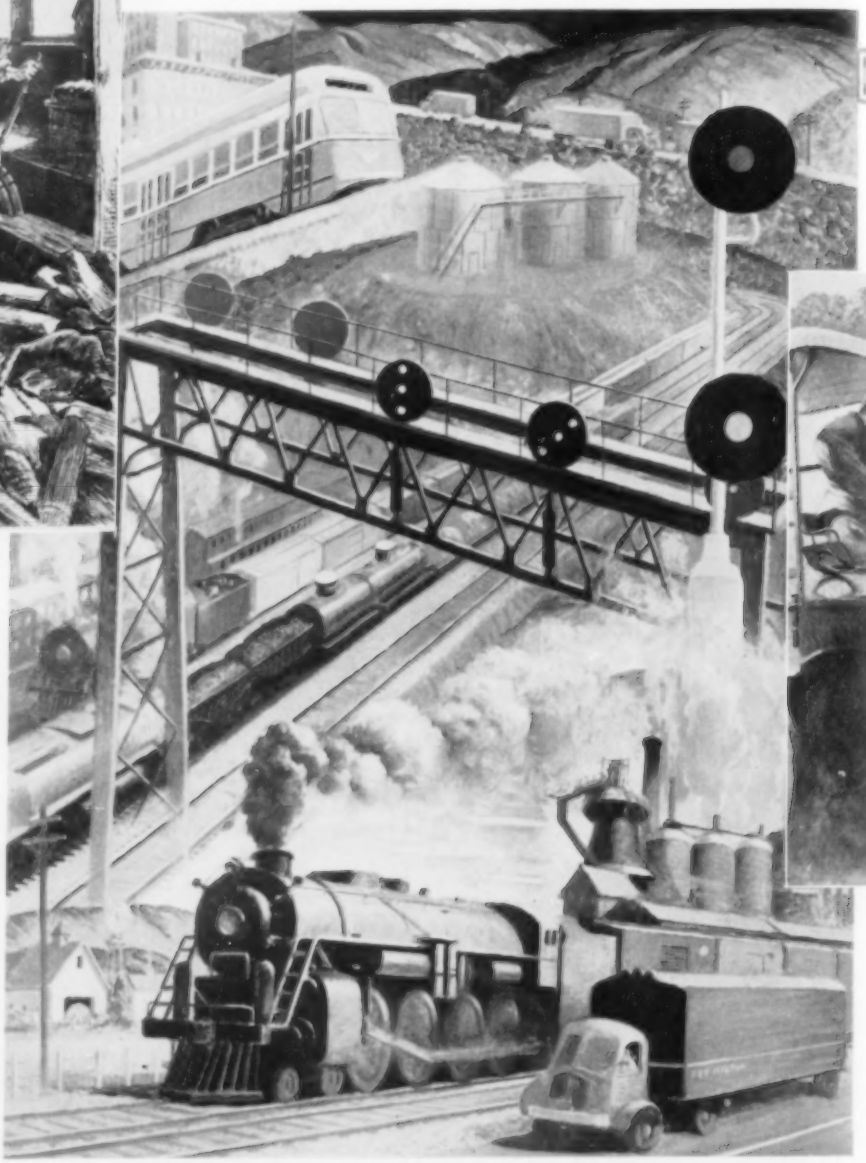
75 Years of Air Brakes

C. H. Vivian

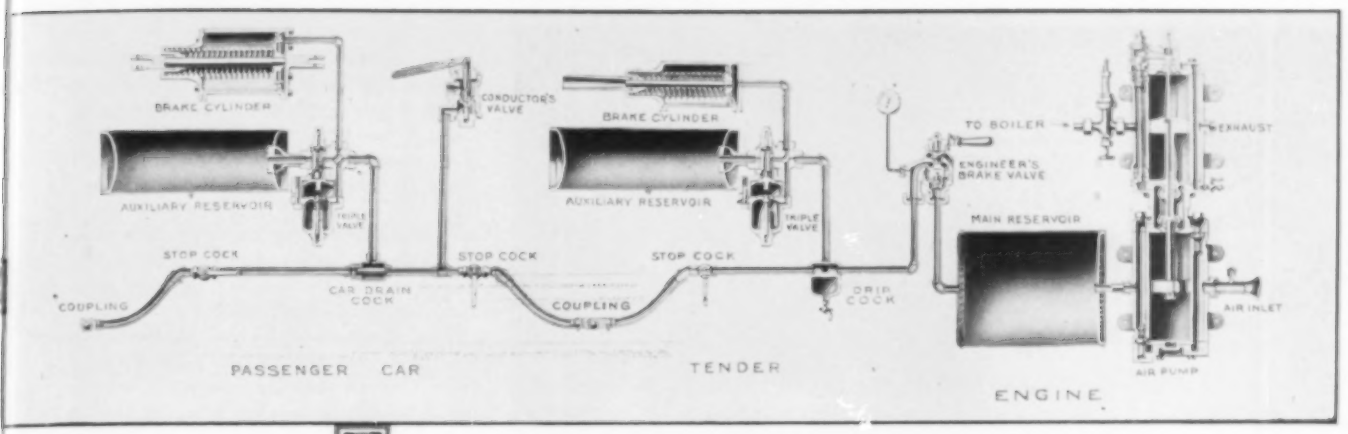


THIS year marks the seventy-fifth anniversary of the Westinghouse air brake, an invention that has had a far-reaching effect upon the economic and social development of the United States and of most other countries. The air brake made railroad transportation safer, more dependable, and more economical, thereby promoting a vast expansion of rail systems that pushed back frontiers and brought about the colonization and industrialization of outlying sections. The provision of adequate means for the free interchange of the goods of commerce and the speedy and comfortable movement of people stimulated the cultivation of the soil, the exploitation of timber lands and mineral resources, and the establishment of industries. The air brake was likewise an all-important factor in the growth of urban and interurban electric lines, and has latterly extended its field of service to heavy-duty buses and trucks. All in all, it can safely be ranked among the inventions that have revolutionized our way of living and made mankind's lot a little easier and better.

The creator of the air brake was one of the most dominant figures ever to flash across the nation's industrial horizon. In a little less than 50 years of adult life, George Westinghouse was granted some 400 patents, an average of one every six weeks. Many of these were in the fields of electricity, power generation, and natural gas and, like the air brake, left permanent imprints upon the course of human events. We can do no more here than make this passing reference to them. Along with his inventive genius, Westinghouse possessed organizing ability and good business sense, an unusual combination. This is evidenced by the fact that he established some 60 companies in various parts of the world and actively participated in the direction of most of them. Some of them passed from his control during the 1907 panic. This hurt him keenly, but it failed to cool his ardor for plunging ahead with new ventures. Although a mental giant, he was a simple and modest man. He had but a few years of formal schooling, yet universities were eager to shower honorary degrees upon him. Many of these he declined. He apparently believed, with Edison, that inspiration is largely perspiration, for "his magic wand was persistent effort." When pressed to take a vacation, his stock reply was, "Work is my pleasure."

One of Westinghouse's biographers, Col. Henry G. Prout, has predicted that even a thousand years from now his name will stand high on the list of men who substantially influenced the history of the human race through their contributions towards manufactured power. Whatever his place may be on the scrolls of posterity, there is no doubt that his mechanical creations have had a profound influence upon the lives of millions of persons now living. And among all of them, none has had a greater effect than the air brake.

In 1860, the United States had 30,283



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MOMENTS FROM RAILROADING HISTORY

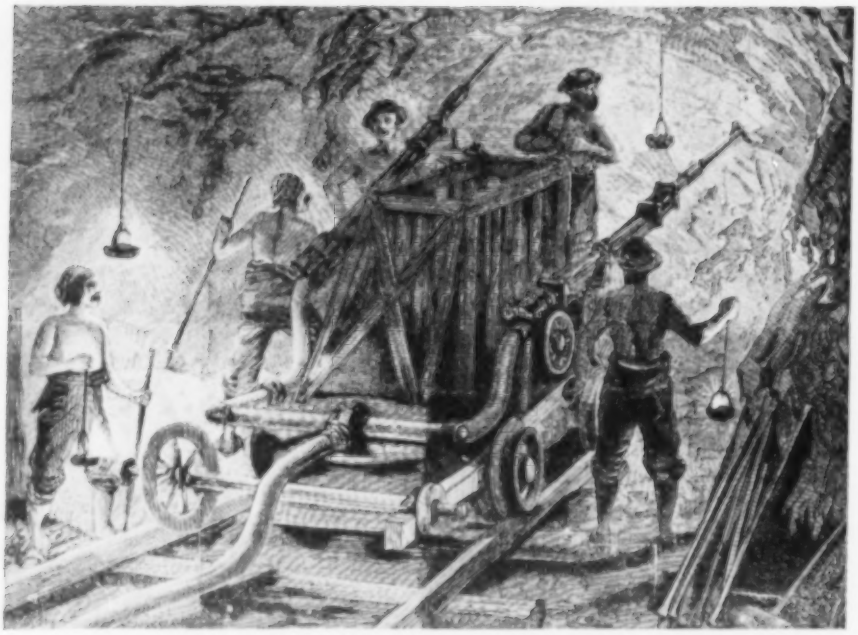
The old drawing at the extreme left illustrates the dangers that attended railroading before the air brake was invented. As the train rounds a blind curve, a man appears ahead, frantically waving for it to stop. The fireman blows "down brakes," the signal for the brakemen to rush to the hand-wheel controls. One of them is shown at his station on the locomotive tender, which contains a supply of wood fuel. Oftentimes the stop was made too late to avoid a collision. The other picture on the opposite page is a reproduction of a painting portraying the significance of the air brake in modern industry. Originally intended for stopping trains, it has now been adopted by most other mediums of transportation. The dramatic, unplanned first test of Westinghouse's invention is depicted at the left. When the first train equipped with air brakes pulled out of the Pittsburgh Union Station and emerged from Grant's Hill Tunnel, the engineer was horrified to see a huckster's cart stalled on the tracks two blocks ahead. He reached for the strange air-brake valve handle and pulled, with little confidence in the result. But the brakes took hold and halted the train just a few feet short of the obstruction. The elements of the plain automatic air brake of 1872 are shown above.

miles of railroads. Ten years later there were 53,878 miles, and it was possible to cross the continent by train because the Union Pacific and Central Pacific lines had been joined in the Utah desert in 1869 by the driving of the historic golden spike. The advent of Bessemer steel rails, the establishment of a standard track gauge, and the linking together of numerous short lines, all portended a still greater expansion of transportation facilities. The biggest drawback was the lack of a dependable brake. The first railroading problem was that of pulling the trains; now stopping them was the difficulty. The engineer would whistle "down brakes" for a regular or emergency stop, and that signal would send brakemen, carrying pick handles, scurrying along the tops of freight cars or rushing through passenger coaches furiously to turn the wheels that operated the hand brakes. Numerous brakemen were required, their work was highly precarious on freight trains, and the results were very uncertain. As often as not, trains overshot stations and had to be backed up. Even though the running speed was low by present standards, a train often could not be stopped soon enough to avoid hitting a chance obstruction on the line, and many bad wrecks occurred.

This condition was brought vividly to the attention of Westinghouse in 1866 when the train on which he was riding between Schenectady and Troy, N. Y., was delayed by a collision of two trains ahead. On a straight track, with clear vision, each engineer saw the other train approaching and signaled for the application of brakes, but there was not time enough to avert a head-on impact. Westinghouse at once became brake-minded, apparently unheedful or perhaps unaware that 600 brake patents had already been taken out. He was only 20 years old, but already had a small factory in Schenectady turning out the products of two of his earliest inventions, a railroad-track frog and a device for putting derailed cars and locomotives back on the tracks. His father owned a small machinery-manufacturing shop in Schenectady, and the son had worked there intermittently from the time he was thirteen. He ran away and enlisted in the Union Army when he was not yet fifteen, but was recalled by his father. Two years later he reënlisted with his parent's consent, became a naval engineer officer, and was discharged at the end of the war in 1865 at the age of nineteen. He then enrolled in Union College, Schenectady, but returned to his father's shop after three months, of his own choice. He attended school only about eighteen months after his thirteenth year.

In his search for a dependable automatic brake, Westinghouse considered and discarded several schemes in turn. The first was a buffer brake on each car that was to be set by impact of one car against another when the brakes were applied on the locomotive. Next, he thought of connecting brakes on each car to a chain and running the chain back from the locomotive through the length of the train. Finally he turned to the idea of a brake on each car operated by a cylinder and supplied with steam by a pipe line from the locomotive. The problem in this case was how to cope with condensation in the system, and he pondered over it without success. During that period he happened to subscribe to a magazine, not because he wanted it especially but because a very attractive girl importuned him to do so. Although he never saw the fair sales lady again, the purchase turned out to be one of the most important he ever made. The first or second issue he received described the use of compressed-air drills in driving the Mont Cenis Tunnel through the Alps. Here was the solution of his problem! Unlike steam, compressed air does not condense, and at Mont Cenis it was being piped hundreds of feet—much farther than would be necessary on a train.

He applied for a patent on July 10, 1868, and it was granted on April 13, 1869. It was the first of 103 Westinghouse patents relating to the air brake.



WESTINGHOUSE'S INSPIRATION

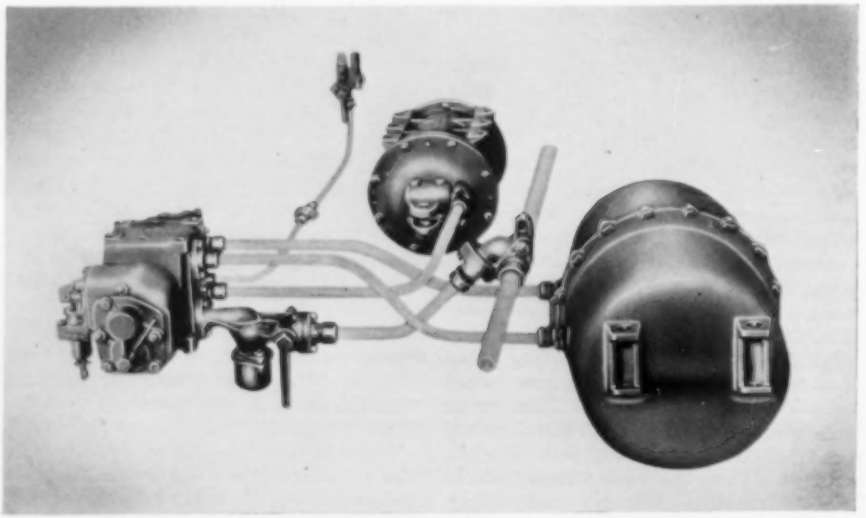
At a time when he was unsuccessfully experimenting with a steam-operated brake, George Westinghouse read a magazine account of the use of compressed-air rock drills in driving the Mont Cenis Tunnel through the Alps. He tried air and it worked. The picture is a reproduction from an old issue of "Harper's Weekly" showing Burleigh rock drills at a Mont Cenis heading.

As inevitably happens, his claims were subsequently assailed, for others before him had conceived the idea of an air brake. To settle the issue, Westinghouse brought suit against a rival concern, and the courts sustained him on the ground that he was the first inventor to bring forward a complete, workable system.

This original straight air brake, as it came to be known, was composed of the following essential parts: an air compressor driven by a steam engine supplied with steam from the locomotive boiler; an air receiver on the locomotive; a pipe line that extended from the receiver to a 3-way cock and thence back through the train; and brake cylinders on the tender and on each car. The air, at 60 or 70 pounds pressure, was admitted to the brake line by operating the cock or engineer's valve. The piston of each brake cylinder was attached to the ordinary brake gear and was thrust forward by the air to apply the brake, the degree of the braking force depending upon the amount of air admitted. Release of the brakes was effected by turning the valve so as to close the air line and to open the brake line to atmosphere, thus permitting the air to escape from the brake cylinders. Between cars the brake line was connected by lengths of hose that were coupled together. These couplings contained valves that automatically opened when the couplings were joined and closed when they were parted. In case a train broke apart, this feature made it possible to use the brakes in any cars remaining attached to the locomotive. A model of the original air brake is displayed among other significant American inventions in the Smithsonian Institution.

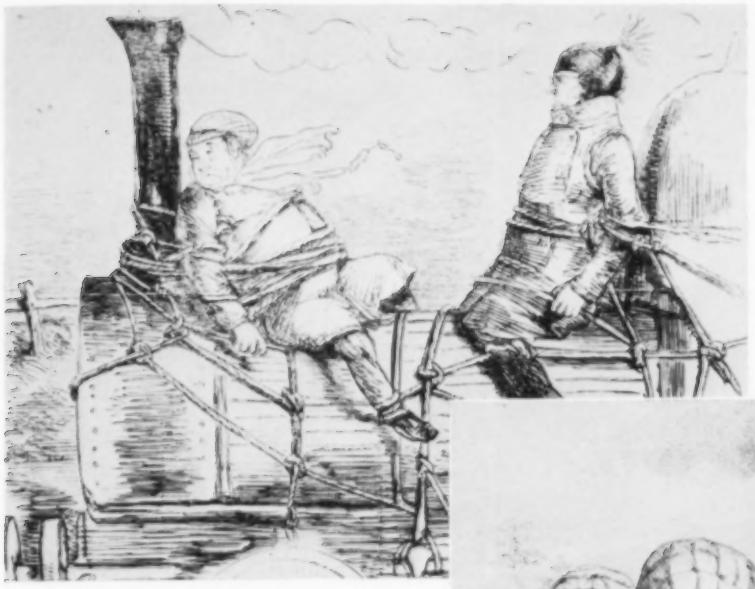
The first application of the Westinghouse air brake was on a train of the Panhandle Railroad that left Pittsburgh Union Station one day in September, 1868. The Pennsylvania Railroad next equipped a train of six cars with the apparatus, and in September, 1869, gave it a thorough test on the steep grades of the Alleghenies, near Altoona, Pa. Following similar demonstrations in several parts of the country, orders for the new brake began to flow in, and by April, 1874, it was being used on 2281 locomotives and 7254 passenger cars, of which some 10 percent were in foreign countries. By means of it, a train of eleven cars, weighing approximately 290 tons, could be brought to a stop from a 30-mile speed in 500 feet, as compared with 1600 feet with hand brakes!

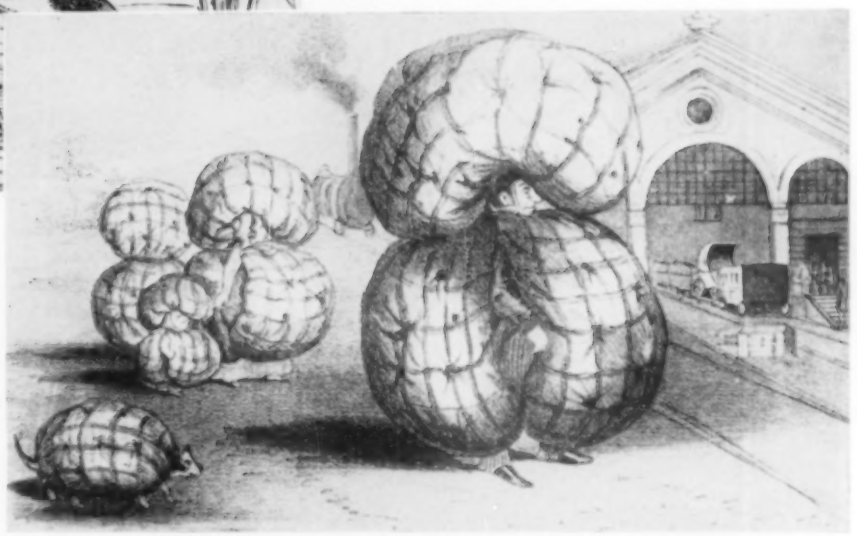
The weakness of the straight air brake was that cars that broke loose from a train had no braking power. Westinghouse overcame this by bringing out an automatic brake in 1872. As finally developed, the heart of the improvement was a "triple valve," a term that has since become a fundamental part of air-brake language. The automatic brake provided for an individual auxiliary air reservoir under each car, with a 3-way valve interposed between the train air line and each reservoir and brake cylinder. In this system, the train air line was normally charged with compressed air, thus reversing the practice with the straight air brake. The engineer set the brakes by manipulating a valve and lowering the pressure in the line. The same result was achieved when the train broke apart, or when the train air line was ruptured through any cause. When the pressure in the air line was reduced, the triple valve automatically closed the connection between that line and the auxiliary reservoir, as well as the port in the brake cylinder that exhausted to atmosphere. At the same time the connection between the auxiliary reservoir and the brake cylinder was opened and the brakes were applied. When the



ASSEMBLY VIEW OF "AB" BRAKE

Introduced in 1932, the "AB" equipment is now the standard brake for freight cars. Its principal elements are illustrated here, being grouped to show their relative positions on a car. The 2-compartment air reservoir is at the right, the brake cylinder in the center, and the "AB" valve on the left. The "AB" equipment transmits braking force at the rate of 930 feet per second by purely pneumatic means.





PRE-AIR-BRAKE RAILROADING

These early cartoons depict the perils of riding trains before the air brake was available. The passengers thought railroad officials were responsible for the many accidents, and the caricature at the left, printed from an 1853 woodcut, suggested that they be tied on a locomotive and made to ride there. The other drawing, published in 1840, recommended padded protection for travelers, both man and beast.

Bettmann Archive prints

engineer closed his valve and restored the train-line pressure, this sequence of operations was reversed, the brakes were released, and the auxiliary reservoir was recharged. Along with the automatic air brake, Westinghouse introduced a method of transmitting signals throughout a train by means of the air line. This has developed into the communications system now in universal use on trains.

Although the air brake was generally adopted before long for passenger service, freight trains continued to use hand brakes for some years with an appalling loss of life among the crews. Agitation for a better braking system was led by L.S. Coffin, Iowa State Railroad Commissioner; and the Master Car Builders' Association arranged for the testing of available equipment on the main line of the Chicago, Burlington & Quincy Railroad at Burlington, Iowa, early in 1886. Four of the six competing companies offered buffer-type brakes, and these were soon eliminated because they made the cars bump into one another and subjected them to a series of violent shocks. This left the Eames vacuum brake and the Westinghouse brake for consideration; but, in the end, they, too, were rejected for the same reason. The Westinghouse brake was all right under normal service conditions, but for emergency stops it was less effective because its slow serial action resulted in serious shocks.

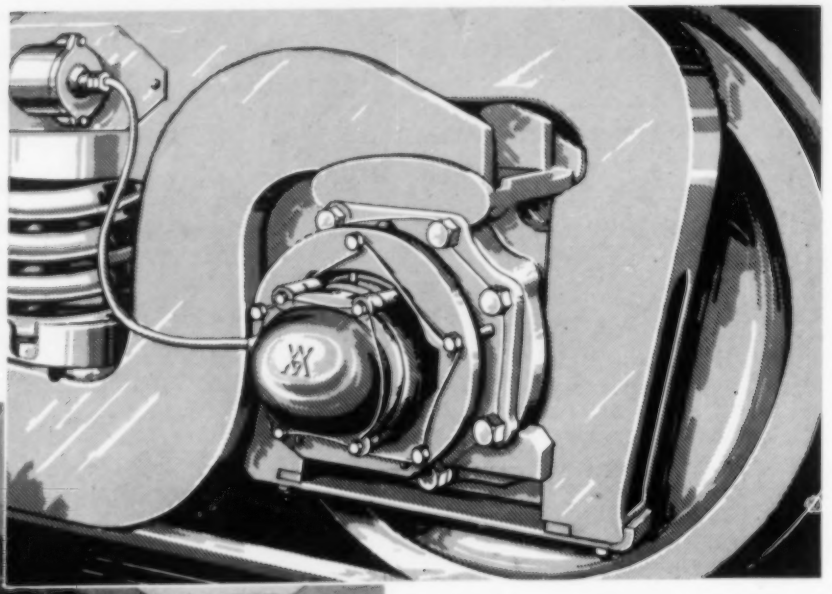
More trials were set for 1887, and Westinghouse prepared for them by developing a quick-acting triple valve that he thought would vent the brake-line pressure on each car simultaneously and thereby put all brakes to work at the same time. But when tested on a 50-car train, the shocks were more severe than ever, especially in the case of the rear cars. This was because the efficiency of the individual brake had been increased to such an extent as to overbalance the serial action which likewise had been stepped up. One of the competing brakes was electrically operated and worked successfully until a wire broke, then it failed dismally. Westinghouse had fortunately provided, at four points on the train, electric vent valves that were energized with current from storage batteries on the locomotive. The brakes so equipped operated instantaneously and uniformly, but Westinghouse did not think electrical apparatus would stand up under the jarring of freight-train service. The committee accepted none of the brakes, but left the subject open to further investigation and suggested a combination electropneumatic brake as the type that seemed to offer the best solution.

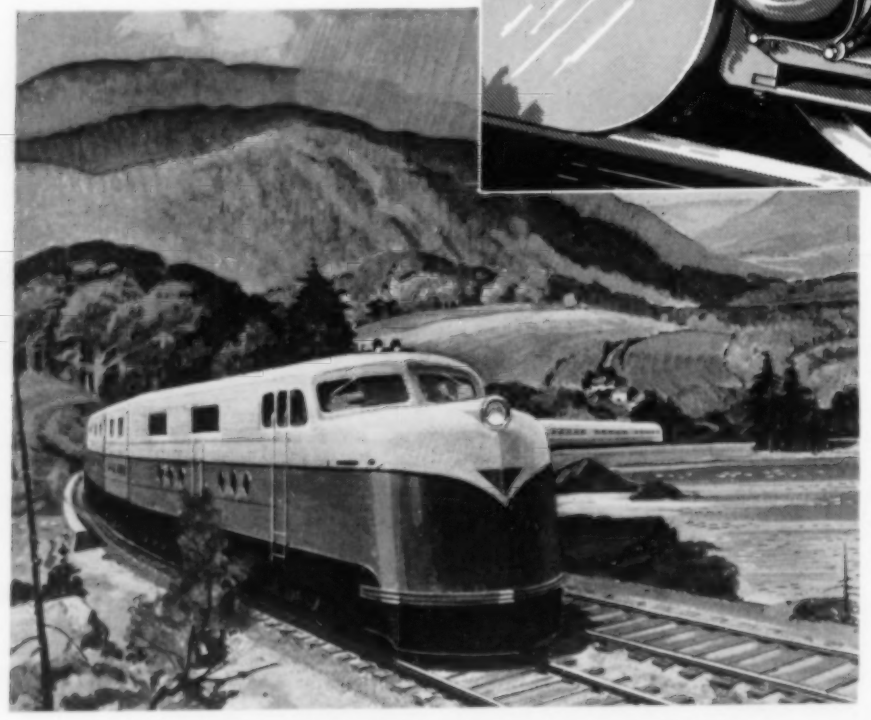
Westinghouse was definitely "on the spot," for he alone held fast to the belief that the most dependable brake was one operated exclusively with air. In the face of this challenge he developed a quicker-acting triple valve by eliminating most of the internal friction and enlarged the train air line from 1 inch to 1¼ inches. As a result of these changes, the time required to transmit the serial action to the last car was reduced from 6 to 2½ seconds, and a 50-car train traveling at a speed of 20 miles an hour was stopped in 200 feet and with so little shock that a glass of water in the last car was not upset. Westinghouse put his new apparatus on the same train that had been used in the 1887 Burlington trials and sent it around the country to demonstrate his device. The performances were so convincing that the Master Car Builders' Association issued a report listing the specifications for a practical type of brake. These were virtually a description of the Westinghouse equipment. The importance of this victory is proved by the fact that nearly 50 times as many freight as passenger cars had to be serviced at that time. In 1893 Congress passed a safety-appliance act requiring power brakes on all railroad rolling stock. Westinghouse equipment was adopted by all the nation's railroads and remained standard until further improved twenty years later.

The valve that solved the situation in 1887 was superseded in 1907 by the "K" valve, which was designed for handling trains up to 80 cars long but had sufficient reserve energy to serve a maximum of 100 cars. In 1932, the "AB" was introduced after exhaustive tests by the American Railway Association had shown it to be satisfactory for service and emergency braking on trains of up to 150 cars. By pneumatic means entirely, it transmits the braking action at the rate of 930 feet a second, as compared with 600 feet by the "K" valve.

HIGH-SPEED PASSENGER-CAR BRAKES

Modern streamliners, such as the one pictured, regularly attain speeds of 100 miles an hour or more, and the brakes designed for them include electropneumatic devices that apply them instantly and simultaneously on all cars of a train. An outstanding feature of the equipment is a speed governor that controls the braking pressure in proportion to the train's rate of travel. One of them is attached to each axle (right) and consists essentially of a generator that measures change in momentum and accordingly adjusts the pressure admitted to the brake cylinder.





As longer, heavier, and faster passenger trains appeared, improved apparatus was needed. In 1894, brake-line pressure was increased, and a high-speed reducing valve was attached to each brake cylinder to limit service-braking pressure to that normally required while providing an initially high but gradually reducing pressure for emergency use. New equipment, called the "LN," was introduced in 1905. It embodied a supplementary air reservoir that was designed, first, for quick recharge of the auxiliary receiver to make the brake more responsive to successive applications; second, for reduction of the brake-cylinder pressure in a series of steps to effect a short, smooth stop; and, third, for high pressure to give greater retarding force when making emergency stops.

Further advances along the same lines were effected by the "UC" brake equipment of 1916 to meet the needs of still longer and faster trains. It provided for a greater difference between the service and the emergency braking force and effected a more positive release of the brakes throughout a train. In 1934 still another system, the "HSC," was developed for service on ultra high-speed trains. It combines electropneumatic, straight-air, and automatic air braking in such a manner that cars so equipped can be incorporated in either extremely fast trains or those drawn at conventional speeds by locomotives that do not have electropneumatic control devices. When forming part of a streamliner, the electropneumatic feature eliminates all time lag in applying the brakes. On a fast train made up of a locomotive and seventeen cars it takes a purely pneumatic system 4½ seconds to transmit the braking action to the rear car. In that brief period, a train running at 100 miles an hour will cover one-eighth of a mile. Through the medium of a speed governor, maximum shoe pressure is applied at high speed and tapered off gradually as the train slows down. Protection against wheel sliding on wet or icy rails is afforded by a device on each axle known as the Decelostat, which automatically vents air from the brake cylinder for an instant in case of insipient sliding.

Locomotive brakes were at first part of the train braking system and were set along with those on the cars. Later it became desirable to apply them independently, and suitable equipment was designed for that purpose. Now, locomotive brakes may be operated with or independent of car brakes, as conditions demand, and both are synchronized so that they will perform in harmony. The locomotive brake may be adjusted to function in accordance with service requirements, insuring control of train slack when handling long freight trains. A changeover device enables the engineman to regulate the emergency-brake control to meet the needs of either passenger or freight trains. The equipment developed for steam locomotives was adapted for electric locomotives when they came into use for main-line hauling.

The first brake for street cars was of the straight air type and still serves, in improved form, for single-car operation. For 2-car operation there is semiautomatic equipment. Normally, the straight air brake is used, but it is provided with an emergency valve that is held in reserve for quick stops and that is a safety measure in case the cars become separated or the air line breaks. In 1916, the semiautomatic brake was adapted for use on the so-called safety car run by one man. It includes a "dead-man" device by which the brakes are set automatically when the operator is negligent or becomes incapacitated. The brake valve also controls the opening and closing of the car doors, which is done with air under pressure. An improved straight air-brake valve, introduced in 1930, regulates the admission of air to the brake cylinder so that the pressure applied is directly proportional to the valve-handle movement. A new type for modern streamlined (PCC) cars was developed in 1936. It combines dynamic,

pneumatic, and magnetic braking, all of which are controlled by means of a foot pedal.

The braking system first used on electric trains (interurban, elevated, and subway) was similar to that with which steam-railway passenger trains were provided, but it was gradually altered because of the difference in operating conditions. Subway and elevated trains must make frequent stops, and the quicker they can be brought to a halt, the greater the aggregate saving in time per scheduled trip. It was recognized in the beginning that brake action could be made rapid and uniform by using electricity in conjunction with compressed air, with the result that electropneumatic equipment was put in service on subway trains in 1910. With improvements and refinements made since then, it remains the basis of the present system. Because of their exceptional passenger-carrying capacity, subway cars have a high ratio of loaded to empty weight. Therefore, to obtain uniform braking action and consistently short, smooth stops under all degrees of loading, the equipment includes a variable-load valve and mechanism that automatically adjust the brake-cylinder pressure to maintain a constant braking ratio.

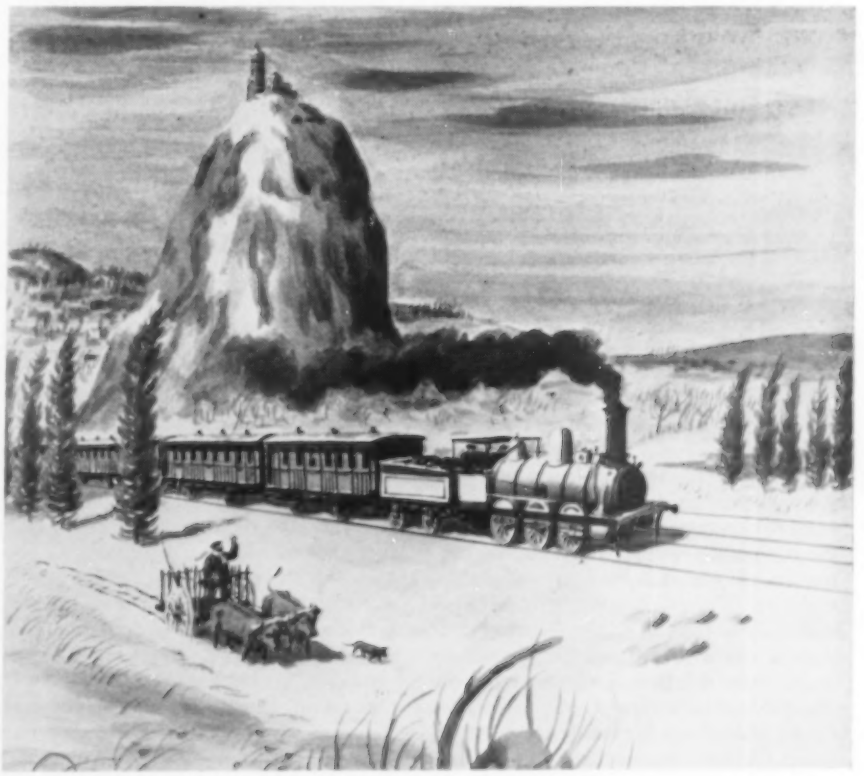
Operating air for railway brakes is supplied by compressors, and these, like the brakes, have periodically undergone change. The single-stage unit that was first utilized was increased in capacity as braking systems required more air. The largest of these had an 11-inch stroke and a piston displacement of 66 cfm. A 2-stage compressor with a stroke of 8½ inches and a piston displacement of 150 cfm. was developed in 1905. Because of heavier and longer trains and the use of auxiliary pneumatic devices such as water scoops, bell ringers, etc., on locomotives, the latter are now often provided with two compressors. For obvious reasons, steam-driven units have always been installed on steam locomotives. When air brakes for street cars were developed in 1901, a motor-driven compressor was designed, and this type has been used since then where steam is not available.

With the rise in bus and truck transportation, it became apparent that something more effective than the brakes on conventional automobiles would have to be devised, and as air brakes had proved themselves in railroad service it was only natural that they should be adopted for heavy highway vehicles. Among the firms making such equipment is the Bendix-Westinghouse Automatic Air Brake Company, which was organized in 1930. In consequence, modern versions of George Westinghouse's invention are serving an industry that did not come into existence until a quarter-century after his pioneering efforts.

The most recent application of pneumatic devices that is an outgrowth of the research work on air brakes is one in the marine field. The movements of ships have traditionally been directed from the bridge, the orders being relayed from that station to the engine room through a signaling system that has become complicated. Below decks, men must carry out the operations necessary to change a vessel's course. When a new internal-combustion engine for a Navy mine sweeper was being designed shortly after the Pearl Harbor attack, marine officers sought a less cumbersome means of control. They pointed out that orders could easily be garbled, and that under combat conditions, when commands often have to be countermanded almost as soon as they are issued, engine-room crews may fall hopelessly behind in carrying out instructions.

From their storehouse of knowledge, Westinghouse engineers were able to devise a type of pneumatic control that can reverse a ship's course in a matter of seconds and greatly improve her chance of escaping from torpedoes, mines, or falling bombs. With fingertip pressure, the pilot can cut off engine fuel, brake the engine, shift gears, release the propeller brake, feed in fuel, restart the engine, and send the propeller shaft into reverse. The pneumatic system cuts the time lag by 90 percent and is foolproof as to errors in operating sequence because all component parts are synchronized and automatic.

In considering the history of the air brake, it should be remembered that George Westinghouse was a manysided man and that his mental excursions led to his participation in many and varied fields of endeavor. One of these, which was closely related to the air brake, had to do with signaling and switching devices for the safe and dependable operation of trains. Out of it grew the Union Switch & Signal Company, which is now a part of the Westinghouse Air Brake Company. Among the more striking developments along this line are automatic block signaling, interlocking systems that make sure that switches and signals will function only in a given order, automatic train control, coded track control, centralized traffic control, car retarders, and a new inductive communications system that permits 2-way conversation between trains on the same track or on adjacent tracks, between units in the same train, and between trains and stations. As might be expected, many of these devices are being operated with the assistance of compressed air.

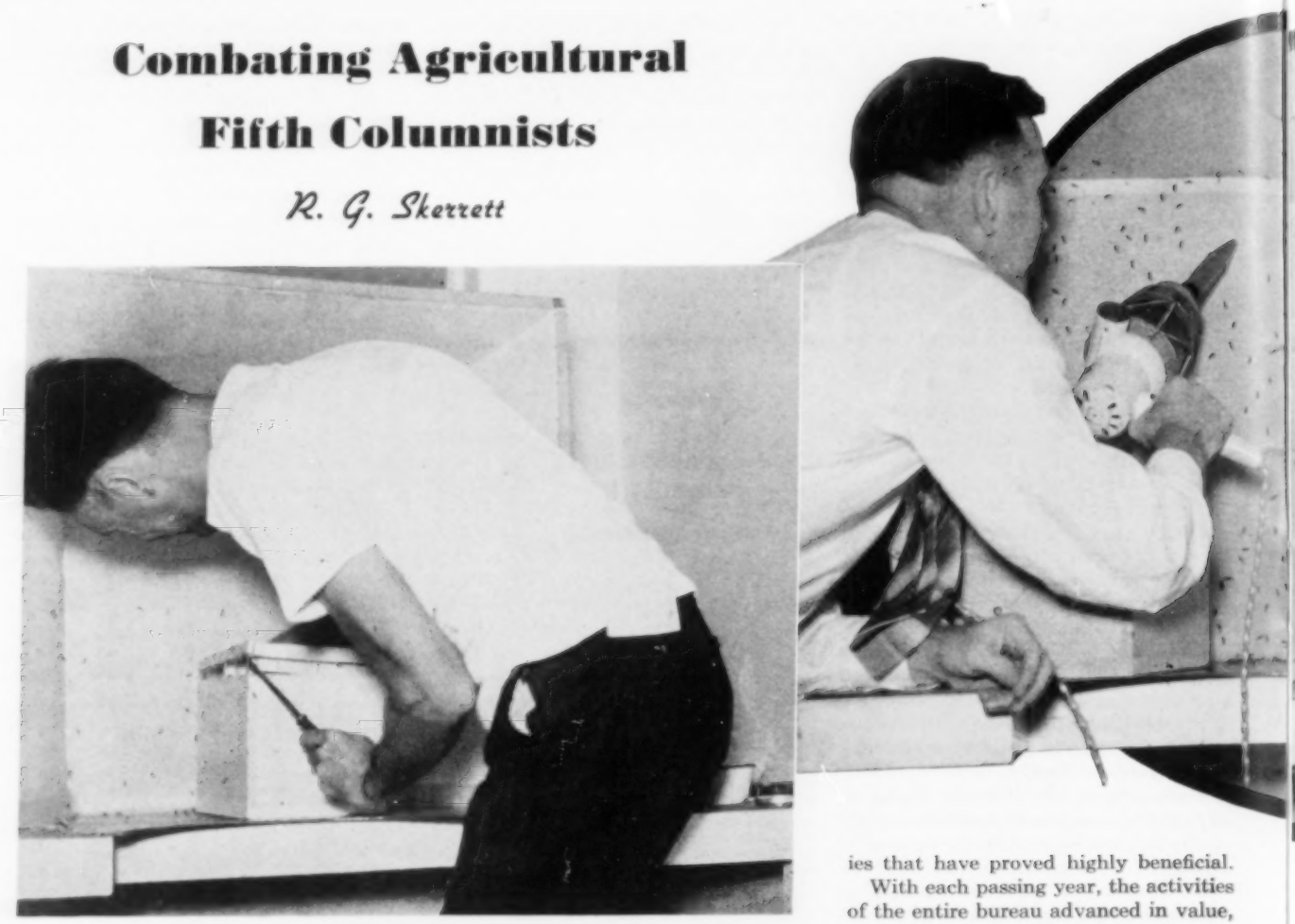


EARLY FRENCH TRAIN

Within a few years after its introduction in the United States, the air brake was in use in foreign countries. France was the first European nation to adopt it for all passenger trains. The picture is from a painting of a train in the chateau section in the 1870's. The air brake was eventually accepted by virtually all countries except England, where vacuum brakes are in general use. Since its first practical application in 1868, the air brake has undergone many improvements.

Combating Agricultural Fifth Columnists

R. G. Skerrett



PREPARING PARASITES FOR THEIR WORK

A Government entomologist is shown above opening a box of parasite wasps shipped in from abroad to prey on the grub stage of the Japanese beetle. The room can be isolated and fumigated to keep strict control over the insects. From the walls of their breeding cage, the tiny wasps are gathered up by a vacuum lifter (center) preparatory to transporting them to beetle-infested areas. Larvae of certain insects are placed in a refrigerator (extreme right) to keep them in a dormant state until the time arrives to implant them in orchards or fields where they will wage battle on undesirable insects. The parasites are shipped from the laboratory in special containers, under refrigeration (lower right).

"SET a thief to catch a thief!" Time has cloaked that dictum not only with added value but also with a measure of decency. To wit—the U.S. Department of Agriculture is applying the basic principle of that old saying in a scientific manner in dealing with some of the numerous plant insect pests that cost us billions of dollars annually. The majority of these damaging insects are said to be of foreign origin. During more than a century and a half, their forebears came to this land virtually unobserved and unopposed. Wherever they found conditions favorable, they established themselves, multiplied their kind, and even spread afar. Today, these undesirable creatures may quite properly be called agricultural fifth columnists.

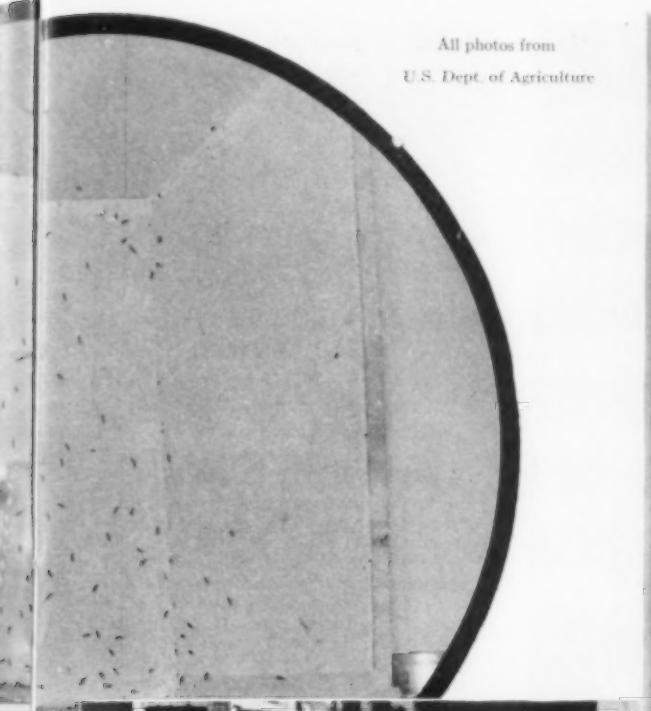
In the records of the Insect Pest Survey of the Department of Agriculture are notes on more than 20,000 species of objectionable insects, and fully half of them are ranked as pests of greater or lesser gravity. Knowing the vital importance of our agricultural activities, it seems well-nigh unbelievable that only since the passage of the Plant Quarantine Act in 1912 has the Government created an organization for halting further entries of these enemy aliens. Now the Department of Agriculture has in its service the Bureau of Entomology and Plant Quarantine which is doing fine and effective work.

Eleven years ago, the Division of Exchange of Useful Insects—later designated as the Division of Foreign Parasite Introduction—was set up within the Bureau of Entomology and Plant Quarantine, and Curtis P. Clausen, senior entomologist, was placed at its head. He was chosen for that important assignment because of his years of experience in exploratory work in foreign lands during which he made notable discoveries that have proved highly beneficial.

With each passing year, the activities of the entire bureau advanced in value, and evidence of this was given when the Department of Agriculture built in Hoboken, N.J., its well-equipped station known as the Plant Quarantine Inspection House. Reference to one phase of the work done there was given in the April, 1943, issue of this magazine. Our interest now is centered in what is done on the fourth floor of that building, which is outfitted to function as a special receiving station for parasites that are deliberately brought into the country to help control insect pests already here that do varying degrees of damage to different forms of plant life.

Heretofore, when such shipments reached the United States from our entomologists who were sent abroad to collect the parasites, the latter were handled with the somewhat inadequate means provided for that purpose at the department's various laboratories located throughout the country. By the present arrangement, the reception and handling are centralized at Hoboken, where the host materials and packages pass through the Division of Plant Quarantine Inspection. This prevents the admission of any pest carried by the material, as well as of any fellow passengers such as hyperparasites that are known to prey upon helpful parasites and seriously impair their efficiency or scope of action. The new Plant Quaran-

All photos from
U.S. Dept. of Agriculture

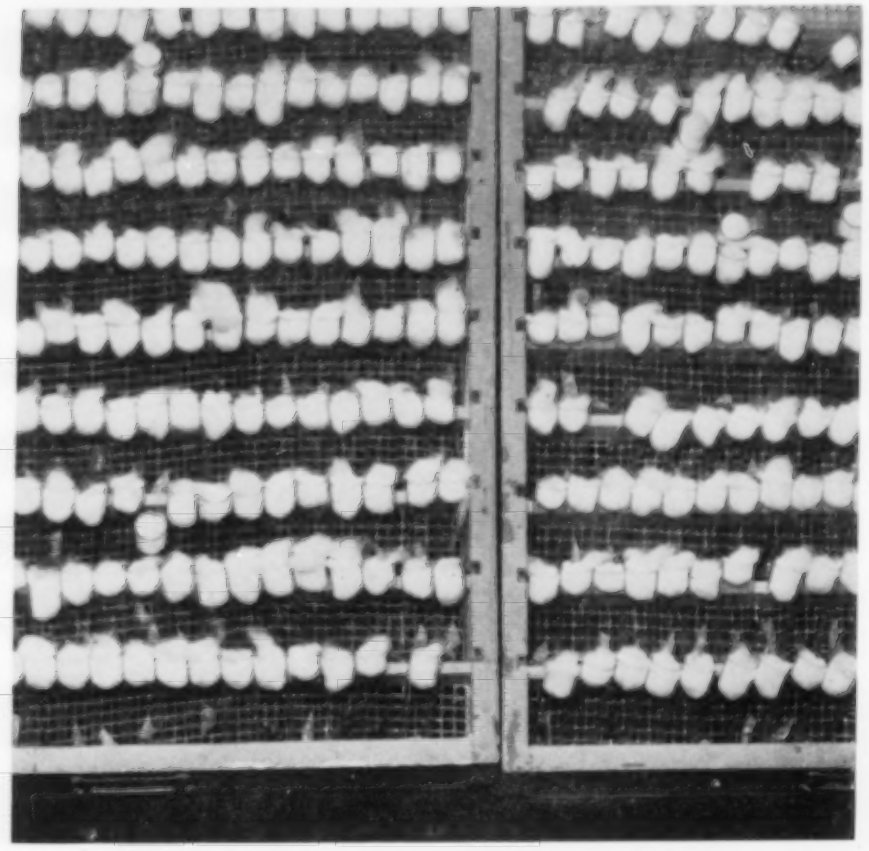


tine Inspection House at Hoboken has now taken over the work formerly done under handicaps at the national capital; and it was logical to place in the same building the Division of Foreign Parasite Introduction so that the two associate divisions could collaborate.

Many of us are familiar with the destructive activities of insects that attack fruit trees, crops, and flower gardens, and we know how sprays and poison baits are used in combating them. But long before man devised chemical means for dealing with these pests with varying degrees of success, nature evolved her own corrective agencies in the form of other insects that instinctively prey upon those that live primarily by feeding on vegetation. The example thus set by nature forms the basis for the present-day practice of control through introduced parasites that attack the insects which cost us more year after year. Remarkable results have already been obtained, but they probably mark little more than the beginning of achievements that may yet be won by our economic entomologists.

As Mr. Clausen has explained, wellnigh every insect in its native home has one or more insects which prey upon it and are dependent upon it for existence. But for these parasites many pests would be free to increase on a scale that would render impossible the growing of crops that are essential to man's subsistence. Numerous insects are capable of rapid and enormous reproduction, and nature has in the course of ages provided definite checks against such unrestricted multiplication to maintain a general balance among living things. Insect parasites are a potent means to this end. For example, the diminutive green aphids which often clutter the stems of roses, sapping the vital fluid of the plant and causing the impairment of the blooms, can complete a generation of their existence in a week or less and would quickly become excessively abundant if no natural restraining agencies intervened. Although weather or climatic conditions may be prime factors in reducing the numbers of insect pests during any season, yet the helpful parasites are of nearly equal importance in bringing about the desired control.

It is a well-known fact that where plant pests have long been localized in any section of the world, those insects are less destructive per unit of area infested than when they are transported to a country new to them. If moved to a favorable environment, the newcomers



BEETLE-BATTLING LARVAE

In the view above, the larva of a digger wasp is shown feeding upon a Japanese beetle grub. The adult wasp seeks out the grub in the ground, stings it, and at the same time deposits eggs from which the larvae hatch. After the latter have completed their work, they weave cocoons for their long transitory resting period. Some of them are then taken from the soil, placed in glass vials and kept in racks (left) until the adult wasps come out to start a new life cycle.

thrive and multiply greatly in a short while and so begin to do more or less extensive damage to some of the vegetation. They flourish and increase because in the new region there is an absence of the parasites that checked them in their foreign setting.

The problem of the entomologists of the Department of Agriculture is to trace the objectionable insects back to the lands of their origin and to discover the parasites that thrive upon them. It is also necessary to study the parasites in their native habitats so as to determine their promise of usefulness if introduced into the United States. If practicable, colonies of the helpful creatures are sent to this country for rearing under laboratory conditions; and when a sufficient quantity of a given kind has thus been obtained, the insects are transported to the areas infested by the pest that is their natural prey or host. It is obviously not feasible to provide colonies for liberation on every farm or in every orchard, but they can be placed at such intervals in a troubled region that the natural multiplication of the parasites will soon bring about a far-flung distribution that will check both the number and the spread of the plant insect pest.

The use of parasites to arrest the activities of crop pests is nothing new. As far back as the latter half of the eighteenth century, Peter Forskal, a Swedish naturalist, visited Arabia where he saw in Yemen how the native growers combated the local ants that attacked their date palms by introducing from the mountains another species of ant that destroyed the troublemakers. A similar practice has been of long standing in various Asiatic countries; and it seems that even today the growers of citrus fruits in South China often place bamboo runways between the trees in their groves to make it easy for ants to travel from one tree to another. The helpful ants, while broadly grouped as parasites, are now classed by entomologists as predators because they prey upon their quarry without previous association with them. In the more restricted sense, as today employed by entomologists, parasites refer to those insects that in one stage of development or another actually evolve within or upon their chosen insect hosts, killing or so impairing them that they usually are unable to reproduce their kind.

The Division of Foreign Parasite Introduction at Hoboken was, until lately, directed by T. R. Gardner, entomologist, who spent some years in the Orient in his specialized work. Before Mr. Gardner joined the Army, he pointed out to the writer that even though several American authors had, between 1872 and 1882, suggested the use of parasites to combat plant pests in this country, no steps to that end were taken. It was an Anglo-American entomologist, Charles Valentine Riley, collaborating with a French entomologist named Planchon, who initiated the international movement of parasites by sending from America to France certain mites that were known to feed upon the grape-vine Phylloxera—a form of aphids—and that were effective in this country in restricting the damaging activities of those insects. The object of the shipment was to save the vineyards of France that were then being grievously ravaged by Phylloxera.

Ten years later, Riley was instrumental in bringing from England to our shores a parasite to prey upon a cabbage worm that was at that time causing great losses to our growers. These early efforts in the United States to utilize parasites blazed the way for a systematic search in foreign lands of natural enemies to combat alien insect pests that had gained unsuspected entrance in this country and had become established here. Our pioneer entomologists proved the value of their services, especially when they combined with their technical training a flair for exploration; and their brilliant achievements have been an inspiration to the men who have followed them.

In this particular field the Department of Agriculture led the way by sending Albert Koebele to Australia in 1888 in quest of any natural foes of the cottony-cushion scale, an insect that was known to have been accidentally introduced from that country or New Zealand and that threatened the extinction of California's orange and lemon groves. Koebele found that the scale did occur in Australia but was not injurious to the citrus trees. He further learned that it was much more abundant and very damaging in neighboring New Zealand.

Reasoning that the relative immunity of the groves in Australia was probably due to the presence of some controlling parasite that was not active in New Zealand, he sought and discovered a ladybird beetle that subsequently became world famous. It was then called *Vedalia cardinalis* but later named *Novius cardinalis*.

Koebele shipped 139 of those beetles to California in the latter part of 1889 and early in 1890; and from them were reared many others. In June, 1890, about 11,000 of the predators were distributed to 208 orchardists, and within the amazingly brief period of a year the cottony-cushion scale was well-nigh eradicated from the California groves! Never since has the scale revived as a menace; and ladybird beetles are kept continually on hand by the state authorities for release should it reappear anywhere. That accomplishment by Koebele enjoys a classic preëminence, and well it should. During his quarter of a century of work for the Department of Agriculture he was responsible for the introduction of many other beneficial insects.

George Compere of the California Board of Agriculture went to Australia in 1898 and on to the Far East in search of parasites and predators that would attack scale insects that were then troublesome in California; and in the course of the succeeding years, his activities carried him around the world. Dr. Frederick A. G. Muir was another of our "bug hunters" that traveled far and wide in quest of natural enemies of plant insect pests. In 1905, while identified with the Hawaiian Sugar Planters Experiment Station, he started a search in Oceania for a parasite that would be effective against the sugar-cane borer. His efforts were finally rewarded by the discovery of such a parasite on the Island of Amboyna, one of the Moluccas, a possession of the Dutch East Indies. That small fly, sensitive to cold, presented many difficulties to Muir in devising means of safely transporting it to Hawaii; but success was his reward. The accomplishments of these three men profoundly influenced others in the field of insect control not only at home but throughout the world; and in the years following, the U. S. Department of Agriculture has had men so engaged in foreign countries well-nigh continuously.

Our importation of parasite material has had peak periods at different times, depending upon the harmful activities of one plant pest after another. The first of these was between 1890 and 1894, when scale insects or aphids were rampant in the citrus groves of California. Between 1905 and 1909 parasites were shipped from Europe and Japan to combat the gypsy moth and the brown-tail moth which came to us from there. These pests have done much damage to evergreen and deciduous shade trees by stripping them of foliage and in many cases killing them. The brown-tail moth attacks fruit trees. Each of these insects does its destructive work while in the caterpillar stage. Imported parasites have been effective in keeping the harmful moths under control, but the battle has cost millions. Without these restraints, the losses would have reached far greater proportions.

Between 1920 and 1930, the Division of Foreign Parasite Introduction imported predators from Europe and the Orient to combat the European corn borer and the Japanese beetle, and we are winning against those pests. Within the last ten years our entomologists abroad have sent us parasites that are known to be the natural enemy of the Oriental fruit moth, as well as foes of several forest and other harmful insects. Recently, the division has been coöperating with the California state authorities in finding and rearing parasites that can be used against the red scale, which originated in Japan and is destructive to citrus fruits; the pink bollworm, an intruder from Mexico which is a menace to our cotton fields; and a mealy bug from China which has given trouble in the apple orchards of the Shenandoah Valley of Virginia. It has been found that the Australian ladybird beetle is highly effective in controlling mealy-bug infestations. But the search for other predators goes steadily on, for success is of immense economic value.

The problems involved in this work are usually complex, according to Mr. Gardner: "Unfortunately," he states, "a parasite that may be effective in its land of origin may not be of equal value after it arrives here. In northern Japan, for example, there is a fly, the *Centeter cinerea*, which is a parasitic control for the Japanese beetle; but in this country that fly has been virtually of no value at the present time, and all because it does not appear in season to synchronize with the beetle's issuance from the ground. Probably as the Japanese beetle works northward into a climatic zone in which the time of its emergence will coincide with that of the parasite—as it does in northern Japan, then the fly will be of similar help in checking the ravages of the Japanese beetle.

"When parasite material reaches the United States, the shipment is unpacked in accordance with quarantine requirements, and all packing media and shipping containers are promptly destroyed to prevent the introduction of undesirable insect pests or plant diseases. If the desired parasites are of adult age, they are conditioned by supplying them with fresh food and water, repacked in special containers, and forwarded to their destinations. Shipment is made by

STUDYING THE RESULTS

Here an entomologist is checking up on the progress being made in parasitizing moth eggs with smaller eggs of a very diminutive wasp. The wasps that are hatched mate and, in turn, lay eggs in other eggs of certain moths that damage citrus-fruit trees. Thus, when they are once established, their instinctive process either greatly reduces or completely destroys later generations of the harmful pests.

CAROLINA MANTIS

Popularly known as the praying mantis, this helpful insect assumes its reverent attitude while waiting for its prey. It feeds on a wide variety of beetles, flies, aphids, and other pests.

air express if practicable; and in some instances parasites sent from Hoboken at 4 o'clock one afternoon have actually been placed in the field in California before 10 o'clock the next morning.

"Should the arriving parasites be immature, then they are reared to adult stage at Hoboken before they are dispatched to an infested area. This is done in cubicles of which there are eleven 8x12 feet in plan and 7 feet high and one 16 feet long and 12 feet wide. Each can be air conditioned to meet the particular needs of the parasite being reared or bred therein, and each has its own water supply. Four are refrigerating rooms where the insects are held dormant."

The facilities make it possible to keep the parasites in storage for release in time to coincide with the seasonal appearance of the insect pest they are to combat. Compartments can be chilled to 50°F. to arrest their development at any stage and for a day or two, if necessary. In one cubicle they can be held for considerable periods by lowering the temperature to any point down to freezing to keep the predators dormant and then raising it to promote normal development so that they will be just right for "transplanting" in colonies to do their helpful work.

When ready for transfer to mating cages or shipping jars, the parasites are collected by vacuum apparatus of different kinds. A vacuum up to 28 inches of mercury is used and is induced either by a vacuum pump or by means of compressed air, which is stored in a receiver and maintained at a pressure of approximately 80 pounds. Compressed air also serves to control the valves of the air-conditioning system. In the metal door of each cubicle there is an inlet valve that is ordinarily kept closed and through which hydrocyanic-acid gas or a similar disinfectant may be blown to kill any insects remaining in it. An exhaust pipe in the ceiling carries away the deadly air after fumigation, following which the chamber is prepared for newly arriving parasites by admitting fresh air. The air-conditioning system is not opened until after this has been done lest the fumigant be drawn in and do damage.

Many of the predators with which the Division of Foreign Parasite Introduction has to deal, either in the field or at Hoboken, are extremely minute, and among the most effective of them are different kinds of wasps that lay their eggs within the bodies of the insects which they attack. The pests may be tiny aphids or plant lice, or possibly scale insects or mealy bugs. The female wasp will pierce the body of its prey and implant its eggs. A week later an adult wasp will emerge and consume the substance of its host before starting its own life cycle. One adult wasp may thus destroy 100 or more aphids. Certain parasitic flies attack caterpillars and deposit their eggs either in or on their bodies. They may carry as many as 50 or 100 of these eggs, which hatch within a few days, the resultant maggots feeding upon the blood and tissues of their hosts. Some wasps that prey upon destructive caterpillars are so diminutive that several thousand of them may develop from a single caterpillar.

The larvae or grubs of the Japanese and other beetles are attacked while in the ground by small digger wasps and combated in this manner. On the other hand, great numbers of insect eggs are destroyed by minute parasites that develop in them. Some of these egg parasites are so small that nearly 100 may reach maturity in each of the eggs of the larger moths they serve to control. The adult wasps of these species may be but 1/25 inch long. The destruction of eggs reduces the number of insect pests that otherwise might hatch out and damage vegetation.

"TIPHIA POPILLIAVORA"

A greatly enlarged likeness of the adult female of the black digger wasp, one of our most valued parasites. It attacks the Japanese beetle while the latter is in the larval stage underground.

The foregoing facts are little more than a hint of the fascinating story concerning the activities of parasites that feed upon other insects naturally, and which the economic entomologist is using more and more to prevent the ravages of the insect fifth columnists which cost us dearly and would grow more menacing with time if not dealt with effectually. According to Dr. Lee A. Strong, chief of the Bureau of Entomology and Plant Quarantine, the Division of Foreign Parasite Introduction has brought into this country from Europe, Africa, Australia, Japan, and other lands more than 400 species of insect parasites and predators. Some 70-odd of these have become established within our boundaries and have proved to a greater or lesser extent of help to us. This work of the Department of Agriculture will inevitably increase for the benefit of the nation at large.

DOOMED TOMATO WORM

A Victory-garden pest laden with cocoons of the parasite "Apanteles," which will eventually kill the worm.

Some Pneumatic-Tire History

Allen S. Park

L. Goodrich photos

EARLY AMERICAN TIRES

The automobile pictured is the No. 1 Winton that was sold to Robert Allison, a mechanical engineer of Port Carbon, Pa., on March 24, 1898, for $1000 cash. George Hilterman is the driver. The vehicle is now in the Smithsonian Institution in Washington. The other picture shows the tires made in 1896 by The B. F. Goodrich Company for Winton's experimental car. Winton found that single-tube tires punctured easily and tried pumping molasses into them to seal leaks. When he pumped too hard, the rubber gave way and he was showered with goo.

THE pneumatic tire undoubtedly represents the commonest use of compressed air. It cushions the daily rides of millions of persons, whether they travel in private automobiles or public buses, in trucks, or on bicycles. In recent years its use has spread to farm tractors, construction machinery, lawn mowers, and the like. Even airplanes are shod with air-filled tires, and they would find it difficult or impossible to take off or to alight safely without them.

As is true of many other useful articles, the pneumatic tire had two inventors. Its originator was Robert William Thomson, a fact that is attested to by a bronze tablet that was placed at Stonehaven, Scotland, in 1922 by the Scottish Automobile Club and the town government during ceremonies in observance of the centenary of his birth. As a youth, Thomson was prevailed upon by his parents to study for the ministry, but he experienced so much trouble with Latin that he veered from that educational path.

The pneumatic tire will be 100 years old next year, for Thomson took out his first patent in 1845 at the age of 23. He specified that "the invention consists in the application of elastic bearings round the tyres of wheels of carriages, rendering their motion easier and diminishing the noise they make in motion." He set forth that its value lay in the fact that "pneumatic tyres absorb the obstacles met with on the road, so that instead of the wheel of a vehicle having to mount over or crush down the obstacles, the obstacles sink into the soft tyre and little or no vibration is communicated to the vehicle itself." Later patentees used virtually the same language in making their claims.

It will be observed that Thomson thought of tires in terms of carriages, as well he might in view of the fact that carriages were then the principal means of conveyance. The only other application suggested for them at the time was that of cushioning rocking chairs. He equipped a brougham with tires (reported to have been 5 inches in diameter), and it covered 1200 miles before they gave out. But the world was apparently not ready for the invention, for it caused no more than a ripple of excitement, and pneumatic tires did not come into general use. One reason therefor probably was that satisfactory tires could not then be made, as the practicability of vulcanization had not been proved (Goodyear's first patent on the process was taken out in 1844). Thomson's tires had an outer casing of leather and an inner tube of canvas and rubber. It will be recalled, however, that even after dependable pneumatic tires became available they were not applied to horse-drawn vehicles, save in the case of racing sulkies. Consequently, it can be concluded that the invention fizzled out because it was ahead of its time.

In any event, Thomson didn't devote much effort to trying to popularize his brain child, although he did patent it in France and the United States. Instead, he turned to the exploitation of other ideas. It is worth noting that one of these was a traction engine and that he equipped its driving wheels with solid rubber tires, not with the pneumatic

type. He also invented sugar-mill machinery, had a part in originating the floating dry dock, and is reported to have first suggested using electric current for firing explosive charges in mines. Strangely enough, he is given little acclaim for conceiving a very practical article now in general use—the fountain pen. Thomson died in Edinburgh at the age of 50.

The second inventor, or reinventor, of the pneumatic tire was John Boyd Dunlop, who was born on a farm in Scotland in 1840. He became a practicing veterinary surgeon in Belfast, Ireland, in 1867; and, although an ardent horseman, he bequeathed to the world one of the most important adjuncts to the "horseless carriage" and thus did much to banish the horse from the highways. This came about because Dunlop noticed that his 10-year-old son had hard work in making his steel-tired tricycle go. In seeking to remedy this, the thought came to him that the vehicle might be equipped with rubber tires inflated with air, and thereupon he began a series of experiments that produced a pneumatic tire that was essentially the same in principle as those we have today. This was in 1888, forty-three years after the issuance of a patent to Thomson. It is doubtful if Dunlop even knew of the latter's creation, which had been pretty well forgotten by that time. He carried on his developmental work in secrecy, and his first crude tires were given an initial tryout on his son's tricycle under the cover of darkness on the night of February 28, 1888, which can therefore be considered the actual date on which the invention was proved successful.

Dunlop filed an application for a patent on July 28, 1888, and it was issued on December 7 of the same year. Some legal difficulties ensued, as Thomson's prior patent was brought to light and made the basis of suits. However, with the aid of some accessory patents, Dunlop was able to establish his claims. Since he was the first person to put pneumatic tires to practical use, he is generally credited with having been their inventor.

Dunlop was able to make pneumatic tires commercially practicable where Thomson failed primarily because he lived in an era when there was a definite field of service for them. The bicycle was at the time in its ascendancy, and it was as a replacement of the solid-rubber tire with which that vehicle was then provided that the pneumatic variety attained its first success. The bicycle was invented in 1840 by a Scottish blacksmith, Kirkpatrick McMillan, but it had not come into general use when Thomson's invention came into being. The early machines were unwieldly contraptions, with one wheel larger than the other and both much bigger than they now are. The wheels were made of wood and had iron tires until 1868, when solid rubber ones were introduced. These were very small at first, but sizes up to 1½ inches in diameter soon appeared. The following year wire spokes were substituted for the wooden ones, and by 1874 direct front-wheel drive had given way to the sprocket-and-chain system connected with the rear wheel. Both wheels were then of the same size, but they were 54 inches in diameter, as compared with the 26-inch size that is now standard on adult models.

By 1888 cycling was of considerable importance in both transportation and sport, and the advent of the pneumatic tire was all that was needed to make it very popular. The first glimpse the public had of the new tires was at a bicycle-race meet at Belfast on May 18, 1889, when a comparatively unknown rider named Hume scored an easy victory with them over the speediest pedalers in that section. Later in the year, a pair of Irish racers riding on air tires outdistanced the cream of England's cyclists, and Dunlop's invention was firmly established.

As is so often the case, Dunlop himself barely tasted of the financial fruits of his creation, although his name still persists in one of the world's largest rubber-manufacturing companies. Tire production on a commercial scale was begun in 1890 by the Pneumatic Tyre & Booth Cycle Agency of Belfast under an arrangement made by Dunlop in conjunction with William H. Du Cros., to whom Dunlop assigned his patent for a modest sum and also received 1500 shares of stock in the company. It was this concern that fought the legal bat-

CASUALTIES OF WAR

A group of battle-scarred tires sent back from the fighting fronts and exhibited to rubber-company workers in Akron, Ohio, where 65 percent of American tires are made, to impress upon them the severe service conditions which their products encounter. Many of the tires show that they were stitched or otherwise repaired in the field, ostensibly because no replacements were at hand. At the right is a tire from a Nazi field gun in Tunisia and patched up by the Germans after it had been damaged by gun fire. This Michelin tire was manufactured in France by the first concern to enter the pneumatic-tire field. Failing to interest any of the French pioneer automobile makers in pneumatic tires, the Michelin brothers, in 1895, built a car, equipped it with pneumatics, and won the Paris-Bordeaux race with it. Twenty-two inner tubes were required to negotiate the distance.

Goodyear News Service

Bettmann Archive

FIRST ENGLISH BUS

The development of the automobile in England was impeded by a law requiring that all self-propelled highway vehicles exceeding a speed of 6 miles an hour be preceded, at a distance of 20 yards, by a man carrying a red flag. The picture shows a steam-powered bus on the London-Birmingham road in 1833.

tles that arose when persons who sought personal profit dusted off Thomson's patent and started suit. The original company was sold in 1896 to E. T. Hooley who formed a stock company, capitalized at five million pounds sterling, which has grown into the present Dunlop Rubber Company, Ltd. Its factories at Fort Dunlop, Birmingham, occupy a 400-acre site and turn out rubber goods of all types. Through subsidiaries, it owns some of the largest cotton mills in the world and controls 60,000 acres of rubber-tree plantations in the Malay Peninsula, now overrun by the Japanese. It owns Charles Macintosh, Ltd., which was one of the first concerns to make articles containing rubber. It was established in 1823 by Macintosh, who discovered a way to waterproof fabrics by dipping them in a solution of rubber and benzine. From cloth so treated he made raincoats, which have ever since been known as mackintoshes.

Dunlop took no further part in the development of tires after the sale of the company, although he lived to see them used by the millions when automobiles became numerous. With the control of his concern in other hands, he apparently was more or less forgotten by the public, and he seemed to feel this keenly. Together with some British automotive engineers, he visited the United States in 1913, but was almost unnoticed and received little publicity other than in the automobile and bicycle trade journals. According to R. G. Betts, of White Plains, N.Y., who was editor of one of these publications at the time, Dunlop was a shy, retiring figure with a flowing white beard and unversed in the ways of publicity. He died at the age of 81 in 1921 in Dublin, where he had acquired an interest in a drapery firm. In his final years, Mr. Betts wrote a few years ago, he was "a frustrated and embittered old gentleman, robbed of the richest rewards of his brain and hungry for the honor or acclaim which had been denied him at home and which he crossed the ocean with the wistful or wishful hope of obtaining on these shores. It was a vain hope, and no creator of a world-revolutionizing invention is so little known, if not absolutely forgotten."

It was, of course, the advent of the automobile that gave pneumatic tires their importance. They were first put on motor vehicles by the French rubber manufacturer Michelin & Company, and were soon adopted as standard equipment on the Panhard, Levassor, and other French cars. Within a few years after Dunlop's patent was issued, several notable improvements were made. Charles K. Welch patented a tire casing having wire edges and a rim to clinch the casing and hold it to the felloe of the wheel. Shortly afterward, William E. Bartlett patented a tire that did not require wire clinchers. The thread or cord tire, embodying strengthening cords in the casing, was invented in England by John F. Palmer in 1893. It was first applied to bicycle and later to automobile tires.

The first cord tires made in this country carried the name of Silvertown and were produced by The B. F. Goodrich Company under the Palmer patents. The cord construction was much

FORERUNNER OF BICYCLE

Freiherr (Baron) von Drais and the "draisin," or running bicycle, that he invented in 1813. The operator got up speed by running, then rode until the machine lost momentum. Drais invented a host of other machines and instruments, but was considered crazy by his contemporaries.

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CYCLING ALONG THE HUDSON

The pneumatic tire eventually made bicycle riding tremendously popular, but it had a hard time gaining acceptance. In 1891, the League of American Wheelmen ruled that racers using the new "balloon" tires must stand a handicap. The following year, the trotting horse Nancy Hanks drew a pneumatic-tired sulky a mile in two minutes four seconds, eclipsing by four seconds a record set in 1885 that was considered unbeatable. Steel-tired sulkies and solid-rubber-tired bicycles soon disappeared. The picture shows cyclists on Riverside Drive, New York City, about 1900. The lady in the foreground is wearing bloomers, named for Amelia Jenks Bloomer, women's dress reformer. The bicycle craze helped break down resistance against this "daring" article of attire.

superior to that previously used, but it was not universally adopted for some years, possibly because of the patent situation. In 1915, all the eleven cars that finished the annual 500-mile race at the Indianapolis Speedway were equipped with cord tires, and all tire manufacturers then began making them. As will be recalled by older motorists, the early tires had many shortcomings which, coupled with the poor highways that then existed, made a Sunday afternoon drive a journey of uncertain duration. It was an even bet that at least one puncture would materialize. No motorist ventured forth without a hand pump and a repair kit, for spare tires were not standard equipment, and garages or gasoline stations were few and far between. It was not until 1917 that a manufacturer put out a tire that was guaranteed to have a road life of 7500 miles.

The first pneumatic automobile tires of any kind produced in the United States were made in 1894 at Hartford, Conn., by the Hartford Rubber Works, which later became a part of the United States Rubber Company. They were single tubes with a cross section of 2 inches and diameters of 44 and 48 inches, the former being used on the front wheels and the latter on the rear pair. These tires were put on the third car made by Charles E. Duryea, his first two machines having been equipped with solid-rubber tires. The pneumatic-tired car won America's first motor-vehicle contest, a 50-mile race from Chicago to Evanston, Ill., and return on Thanksgiving Day, 1895. Over roads covered with 12 inches of snow, Duryea drove the distance in 7½ hours and won a $2000 prize offered by the *Chicago Times-Herald*. Only six of the 60 cars entered were able to get started, and only two finished.

Another pioneer automobile maker, Alexander Winton, was responsible for starting the manufacture of the new tires on a commercial scale in this country. In 1896, Winton was working on his initial automobile in Cleveland and he wanted to equip it with pneumatic tires. None larger than the 1½-inch bicycle type was available in this country, so he put the problem up to Arthur J. Wills, the Goodrich representative in Cleveland. The latter went to Akron and told B. G. Work, then factory superintendent and later president of the company, that Winton wanted them to build him a set of tires.

"It's an experiment," said Mr. Work, after thinking the matter over. "There is no demand for this sort of tire and we don't know whether the horseless carriage will ever become a commercial success. Tell Winton that if he will pay for the molds, we will see what we can do." Winton placed the order on those terms, and the molds cost him about $150. He received four tires, those for the front wheels being 34x4 inches in size and the ones for the rear wheels 36x4 inches. In October of that year Winton's car was running on the streets of Cleveland, and the crowds that gathered around it wherever it stopped never failed to comment on its "enormous" tires.

That was the beginning of the pneumatic-tire business in the United States. Since then it has taken prodigious strides. As cars became larger and faster, the demands upon tiremakers increased. Through research they learned how to build tires that would give long and dependable service, and then devised machinery and instituted methods by which they could be manufactured to sell at progressively lower prices. The tire cost to the motorist for each 1000 miles traveled is now only a fraction of what it used to be. In a normal year the nation's factories produce more than 50 million automobile tires, aside from those for the other types of equipment mentioned in the first paragraph of this article.

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MOTORISTS OF 1902

The first cars all had open tops, and this mode of dress was worn to protect the riders from the clouds of dust that swirled up from the dirt roads as the vehicles whizzed along at speeds up to 20 miles an hour.

G. I. Joe on the "Ding Hao"

Michael M. Harris

Army Signal Corps photos

AMERICAN-MADE MACHINES

At the top, Corpl. John J. Simpson, of Linsay, Calif., a mechanic in the American unit closest to the Japanese lines, stands behind an Ingersoll-Rand trailer-mounted portable air compressor on a hillside above the Salween River. The other picture shows Lieut. Charles H. Gueritey, Jr., supervising a Chinese mechanic at work on an I-R drill-steel sharpener.

EVERYONE knows that American men and American machinery are fighting this war in every out-of-the-way spot of the globe. This is a story about American machinery working farthest from home; working with the Services of Supply Burma Road Engineers from Kunming in southwestern China to the ports of India.

G.I.'s in China have a twofold task. As engineers and mechanics they operate tractors and bulldozers, rock crushers, air compressors, power generators, and blasting equipment to widen, smooth, and level the Burma Road as the Japs are pushed back. The job is to strengthen and maintain the traffic artery to carry the supply loads of 6x6 Army trucks. As technicians and instructors they are teaching Chinese mechanics and engineers how to make the most efficient use of the modern machinery that Services of Supply is shipping in to replace the ancient *tzen tzu* (spade) of the coolies.

The Burma Road is called Ding Hao Highway. "Ding Hao" means "the best." Not that the road is the best; but to coolies and farmers, the Americans with their thundering machines represent everything the Chinese people respect and look to for victory. "Mey Guo Ding Hao!" the Chinese workers shout. "Americans are tops!" Ding Hao Highway is open, if a road with 20 percent grades and hundreds of hairpin turns can be called a highway. One section to which a road grader was recently assigned balances itself at breath-taking heights, with thousand-foot drops first on one side and then on the other.

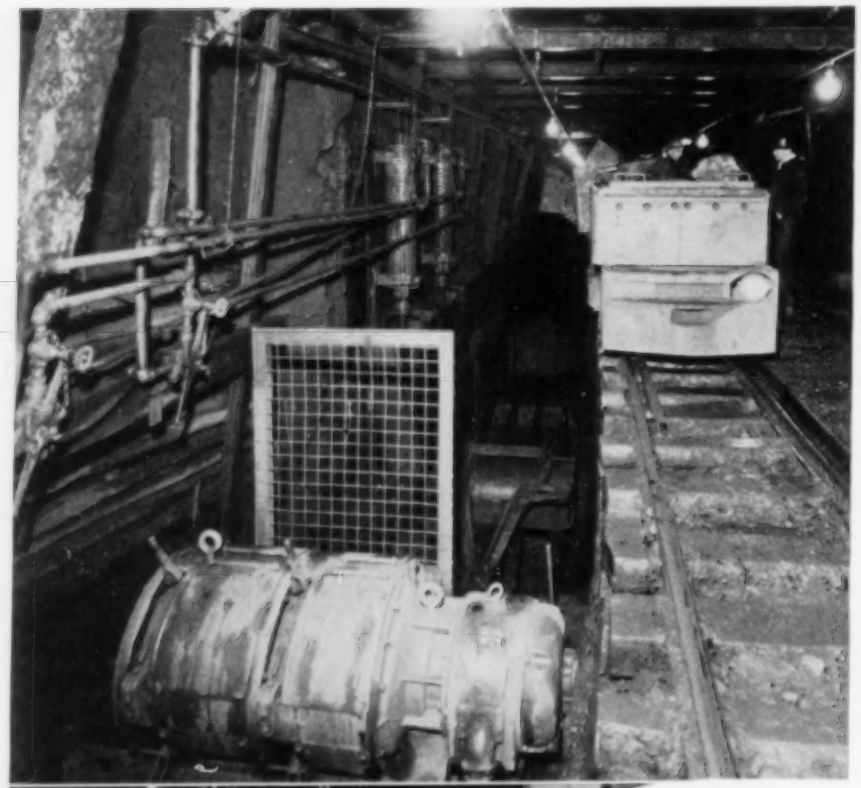
Supplies and troops must advance, so obstacles must be overcome. Ten- and 12,000-foot peaks must be eased by grades and curves. Impassable rivers that whip their way between deep gorges must be bridged. Soft-rock walls must be strengthened, culverts dug. And always hovering Japanese bombers, hunting their prey among slow-moving convoys, must be driven off. On the crest of Tien Tz Miao, a hundred coolies are busy chewing out pieces of the mountain, making wider the sharpest and highest curve. Working with the Chinese using their *tzen tzu* are American-made air compressors and rock drills putting down holes to be exploded by dynamite brought from the United States. Sometimes a bulldozer is held back as machine-gun bullets splatter off angle-dozer or frame. Other times, deep tank traps must be filled.

Through one of the Himalayan valleys runs a broad, wide dirt-and-asphalt road for a distance of nearly 16 miles. The Burma Road Engineers scraped the barrel dry in their efforts to find construction and repair materials. Cans of asphalt were tracked down in abandoned Chinese warehouses. Machinery left along the highway was pieced together into hybrids that had to be repaired with parts made and forged by hand. Every pound of equipment still has to be transported from the States across the Seven Seas. Trucks and trains carry it from the ports of India to plane depots in the northeast, from where ATC cargo planes fly it to fields in China. Breakdowns mean loss of time where time means lives. Some new parts must come from America, and the Engineers watch as avidly for their arrival as they do for personal supplies and, sometimes, mail.

Life isn't too easy for the men. One combat unit lives in the bodies of trucks wrecked by the Japanese. In another truck body that serves as a mess hall and recreation room a pieced-together headset radio has its two earphones fixed in tin cans for amplification so that six can listen at one time. Another unit goes to the "movies" at a Chinese-American field hospital once a week, if there is gasoline that can be spared. When former commander Lieut. Col. Louis Y. Dawson of Charleston, S. C., brought holiday rations all the way from India to the men in the Salween-front unit, a great celebration took place. Ceremoniously they were handed over to Maj. Harvey W. Gehr, the officer in charge, and he in turn gave them to the mess sergeant for distribution.

So things go in southwest China. American men and American machinery are working every day. Foot by foot, the Chinese and Americans, with equipment from American factories, fight nature and the Japanese to open this back road to Tokyo.

Compressed Air at Work

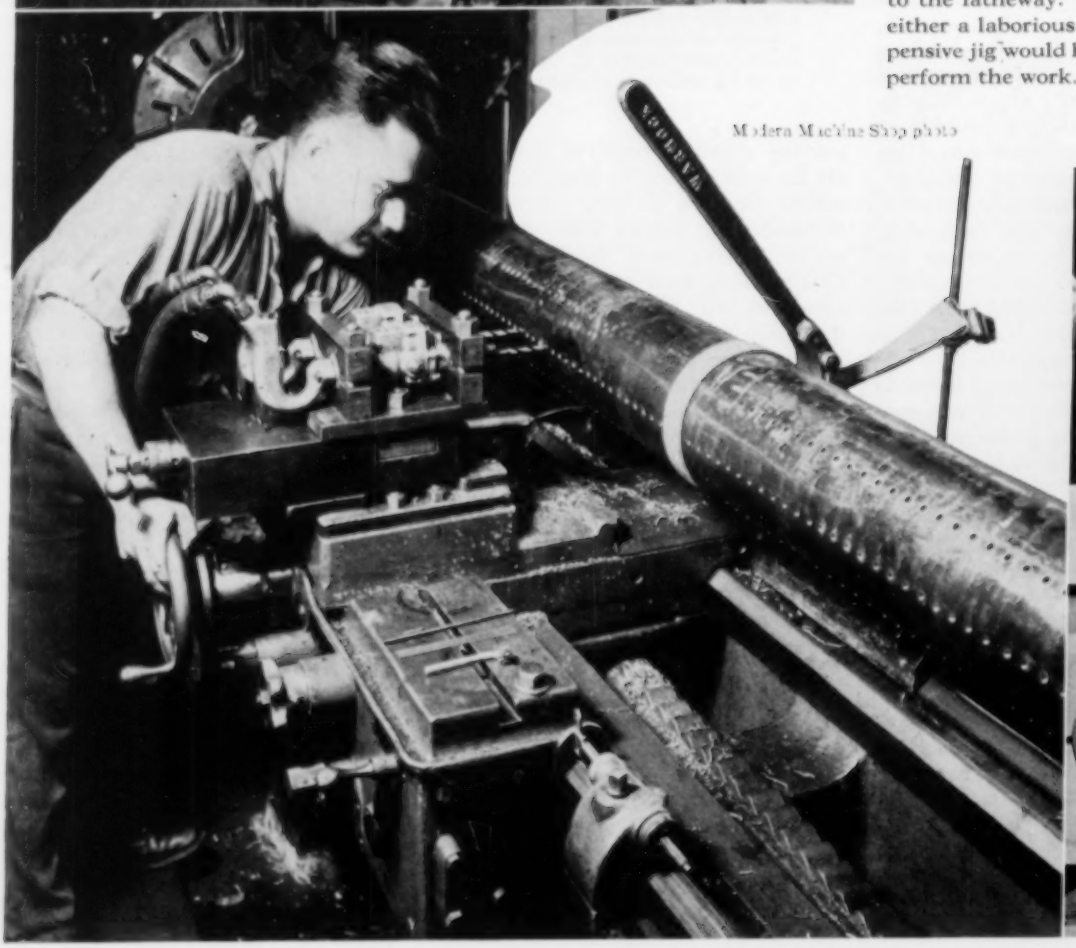


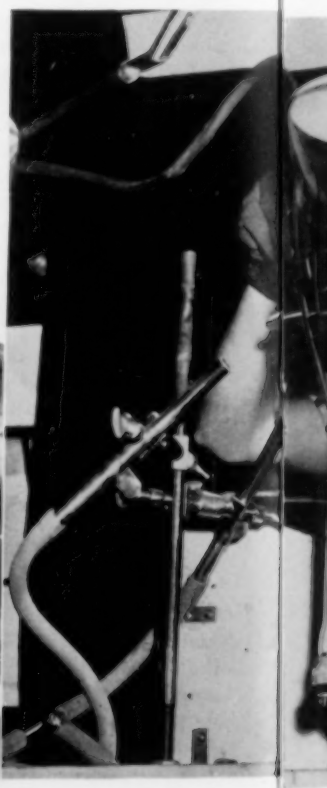
UNDERGROUND in the Mather Mine, Ishpeming, Mich., (left) showing cars of ore being unloaded into a trench by pulling them over a camel-back dumper. From the trench the ore is transferred into a pocket by a scraper (seen in the pit) that is drawn by the hoist at the bottom left. It is then loaded from the pocket into a skip for hoisting to the surface. The pocket gates are operated by the two compressed-air cylinders in vertical position on the wall opposite the locomotive.

•

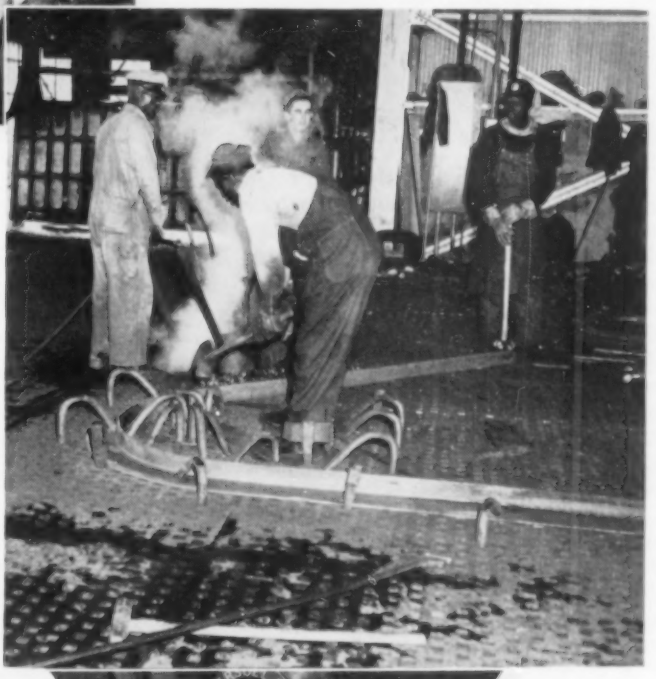
TO DRILL six rows of 200 equidistant holes in an 18½-foot length of 6-inch pipe, machinists of the Westinghouse Electric & Manufacturing Company devised the set-up pictured at the bottom-left. Two air drills were mounted in a holder clamped to the side rest of an engine lathe and spaced so as to assure the desired distance between holes. The first holes were located accurately, and subsequent ones in each row were then automatically spaced by a micrometer stop attached to the latheway. But for this set-up, either a laborious layout job or an expensive jig would have been required to perform the work.

Modern Machine Shop photo

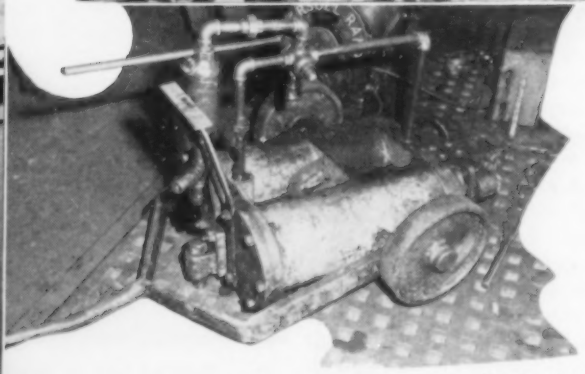




THE pneumatic charger, left, was developed by Walter Kidde & Company, Inc., to clear jammed .50-caliber aerial machine guns in combat service. At the touch of a button, this 2-pound device will restore fire power in one second, and is effective at temperatures down to -65°F. Before it was available, jammed guns had to be cleared by hand, a slow, uncertain operation that also severely taxed human strength at high altitudes. The pilot of a fighter plane had to take his eyes from the controls to clear a jam, and this was highly perilous under combat conditions. The charger is ordinarily operated with air stored in a cylinder at 1000 pounds pressure, and a supply of 57 cubic inches will clear 50 jams.



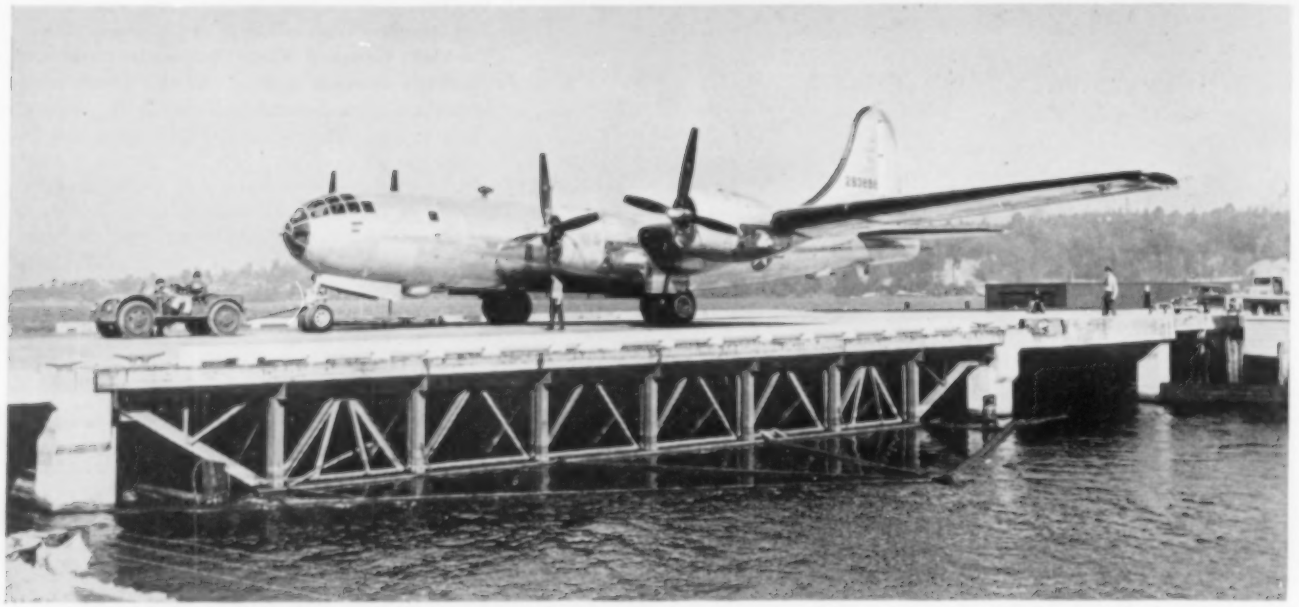
THE compressed air being used by the girl in the picture below is supplied entirely by her own lungs. A worker in the Dobbs Ferry, N.Y., plant of North American Philips Company, Inc., she is sealing a metallic button on a cathode-ray tube. She keeps the tube under slight pressure while a gas burner is rotated around the button. Cathode-ray tubes literally "shoot" electrons at a fluorescent screen and are indispensable to some electronic devices used by our armed forces.

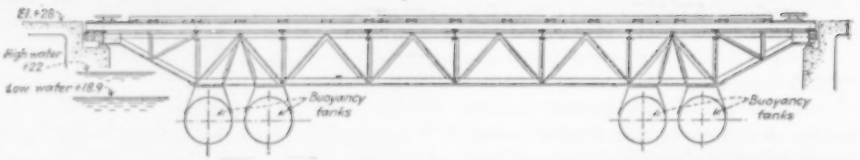


Construction Methods photos

A PACIFIC COAST shipyard employs the pneumatic ram shown above to bend steel channels into the various curved shapes required for the building of U. S. Maritime Commission cargo ships. With one end of a heated channel secured to a steel bedplate, the plunger of the ram then bends the member into shape. The ram is mounted on wheels to facilitate shifting and is held in working position by a pin inserted into a hole in the bedplate. This equipment saves time over the older hand method illustrated at the top. Part of a Utility air hoist is shown behind the ram. These units do many lifting and moving jobs around shipyards.

Floating Runway for Superfortresses





OVERWATER FOR THE TAKE-OFF

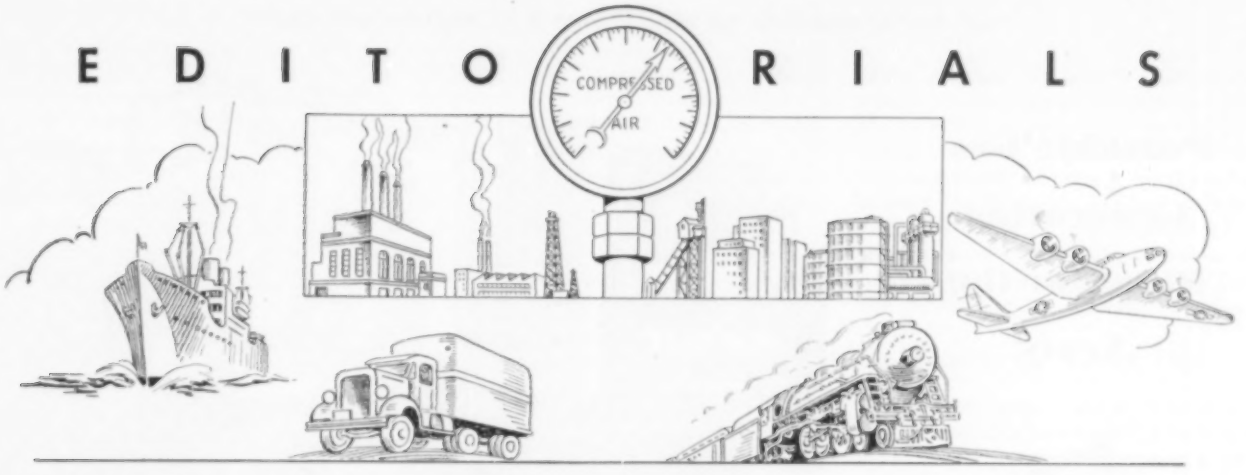
At the top is the floating bridge over which each Superfortress built at the Renton, Wash., plant of the Boeing Aircraft Company has to be pulled to reach the airfield on the opposite side of the Cedar River, which is navigable. The span is wider than it is long, and occasionally has to be swung aside to let boats pass. This is done by means of twelve buoyancy tanks arranged in four rows (center). These tanks are normally filled with water, which is displaced with compressed air when the channel has to be cleared. A section of the plant is pictured at the bottom. It was situated on Lake Washington for the building of seaplanes.

CHANGING over from the construction of sea to land planes posed a problem for the Renton, Wash., plant of the Boeing Aircraft Company. It is situated on the shore of Lake Washington adjacent to the mouth of the Cedar River and was built for the manufacture of the XPBB-1 Sea Ranger, a giant 2-engined flying boat that could get up into the air from the waters of the lake. Subsequently, production was shifted to the B-29, the Superfortress that has recently gone into action against Japan. These planes require a sizable field for a take-off, and the only area available for that purpose was on the opposite side of the stream, which is navigable. This meant that any bridge to serve as a runway across the gap would have to be of a type that could be easily floated away and yet offer a steady platform.

Such a bridge has been designed by and constructed under the supervision of The Austin Company. It has a span of approximately 85 feet and a width of 110 feet. The structure is of steel with a timber deck and rests on concrete abutments to which it is firmly locked by removable pins. In order to float the bridge aside to permit shipping to pass, it is mounted on twelve steel buoyancy tanks that are placed in four transverse rows, as the accompanying drawing shows. These cylinders are normally filled with water. Each is 5½ feet in diameter and 34 feet long and is made buoyant by forcing the water out through an 18-inch-diameter opening in the underside with compressed air at 5 pounds pressure. This is admitted at the top, and is piped from the plant's main compressor station.

The tanks have been built with an ample margin of safety. Should one in each group of six fail to function, the remaining ten would provide sufficient buoyancy to float the structure. Furthermore, should all of them fill with water while the bridge is afloat, it would remain in that condition because of the buoyancy of the deck which, together with the stringers, are of wood. This unusual runway has to be shifted only a short distance to clear the channel.

EDITORIALS



AIR-MINDED WESTINGHOUSE

AN ARTICLE on the air brake in this issue reminds us that its inventor, George Westinghouse, was one of the most "air-minded" men that ever lived. By making the first large-scale application of compressed air in the United States, he drew attention to its possibilities and influenced other inventors to adopt it for operating various tools and appliances. He made the public "air-conscious" and put it in a receptive mood for those forthcoming pneumatic devices. Because air brakes took most of the hazard out of railroading, compressed air became associated with safety, and this undoubtedly had something to do with its acceptance for service in varied fields of endeavor. Because of all these things, Westinghouse might aptly be called the first ambassador of compressed air.

Westinghouse not only pioneered in the realm of pneumatic application, but he carried through in his conviction that air was the most satisfactory and effective power medium for railroad brakes. When his relatively slow-acting pneumatic valve was under fire during the Burlington Trials of 1886-87, he persistently refused to discard it for an electrical device, even though the committee in charge officially went on record in favor of such a change. Instead, he developed a quicker-acting valve that overcame the objections. Concerning this episode, a leading contemporary technical-magazine editor wrote:

"At the conclusion of those trials it is probable that there was only one engineer living who believed that the triple valve could be so altered as to stop a 50-car train at forty miles an hour on a 53-foot grade in less than half the length of the train without a shock . . . and we now tender him our hearty congratulations on this new and most important achievement whereby the necessity, or even the desirability, of an electric complication of the air brake is completely avoided."

Westinghouse made the needful modifications in his equipment in three months, and it was typical of his confidence in his own mechanical capabilities that, after he had supervised the installation of the apparatus on the test train, he did not even wait to see it tried out. He went home to Pittsburgh despite the fact that it was a crucial moment in his career. It was crucial, incidentally, not only for Westinghouse but also for the compressed-air industry. Had his pneumatic valve failed, had it been supplanted by an electric one, the development of air power in general would probably have suffered a serious setback.

As it was, Westinghouse's genius saved the day for compressed air, and from the air brake he went on to use the same agency of power effectively in many of the numerous railroad switching and signaling devices that he invented. In fact, he was so strong an advocate of compressed air that, when the Niagara Falls hydraulic development scheme was first under consideration in 1890, he favored pneumatic transmission of the power that was to be generated there. The commission in charge was at least partly likeminded, for when it invited construction proposals, it specified that it would consider projects for the distribution of the power "by electricity, compressed air, water, cable, or other means."

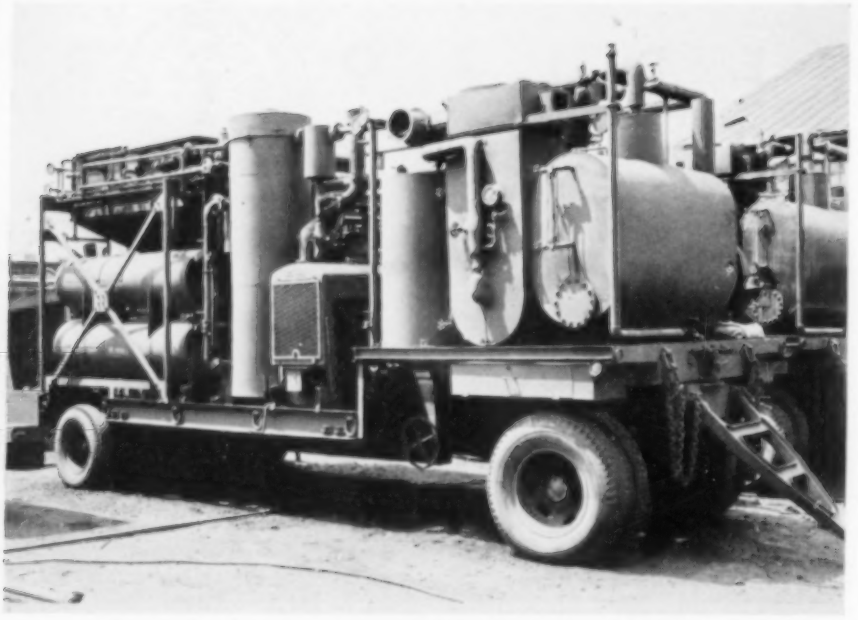
Westinghouse, at the time, leaned toward compressed air even though he had become interested five years before in the possibilities of developing and distributing alternating current. However, no one yet knew much about electric power, and alternating current had not been tried out in this country. On the other hand, Westinghouse had been transmitting power pneumatically for twenty years and was, as we mentioned at the outset, thoroughly air-minded.

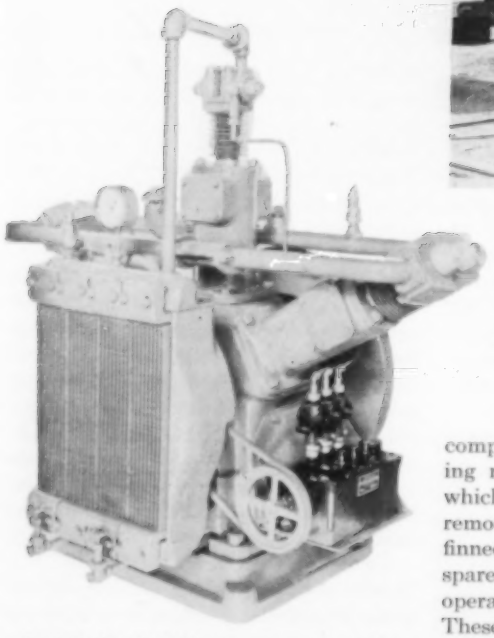
It so happened that some of Westinghouse's brilliant young engineers had more faith in electricity than he had. At their insistence, he contracted, in 1890, to supply a 100-hp. alternating-current generator for a hydroelectric plant at Telluride, Colo. Although the power was carried only 3 miles, the installation was a decided success, and there was a great saving in copper wire as compared with the direct-current transmission system that had been proposed by Thomas A. Edison. The satisfactory outcome of the Telluride experiment (Westinghouse viewed it as such) altered the entire picture at Niagara Falls. Westinghouse changed his mind in favor of alternating-current generators, and his company received the contract and built a plant of unprecedented size that had a revolutionary influence on power development throughout the world. Thus, in effect, Westinghouse launched the electrical industry on a successful commercial voyage, just as he had started the compressed-air industry off a quarter-century previously.

Available technical literature has little to say about uses of compressed air in the United States before Westinghouse embraced it for operating his braking system. We know that Burleigh had already designed an air compressor for running rock drills in the Hoosac Tunnel in New England; and a search of the patent records would undoubtedly reveal that small compressors had also been invented, for others before Westinghouse had conceived the idea of air brakes. Yet we are told that Westinghouse got his inspiration from a magazine account of the driving of the Mont Cenis Tunnel in the Alps with air-operated rock drills.

Pneumatic dispatch systems had been in successful operation abroad since 1853, and William Mann, in England, had invented a compound air compressor in 1829; but these and other pioneering efforts in the compressed-air field had very likely been given little publicity here at the time Westinghouse began his experiments. However, once he had decided to operate his brake pneumatically, the provision of a suitable apparatus for supplying the essential compressed air seems to have caused him little difficulty. At least, his biographers passed over this phase of his invention with scarcely more than the mention that an "air pump" was used.

Portable Gas Generating Plant for the Army





GAS PLANT ON WHEELS

One of the 27 trailer-mounted plants being built by The Girdler Corporation for the manufacture of hydrogen and carbon dioxide at the fighting fronts. Permanent installations of this type usually occupy approximately ¾ acre; this one has been condensed to about the size of a box car. At the left is the special Type 40 two-stage, air-cooled machine that compresses carbon-dioxide gas from 35 pounds to 1300 pounds per square inch.

A PORTABLE hydrogen-carbon dioxide generating plant, mounted on a 16-ton trailer, has passed Army acceptance tests and will soon be exported for use in battle areas. It was designed last December for the U. S. Corps of Engineers by the Gas Processes Division of The Girdler Corporation, which has had extensive experience in gas manufacturing and purification and in the solution of gas problems. Twenty-seven units are in production, and two of them will be kept in this country for training purposes. The total value of the contract is in the neighborhood of $1,000,000.

A unique development, this mobile plant has all the component controls and essential operating features of a permanent installation despite great limitations in weight and dimensions, while simplicity of design and rugged construction will provide maximum efficiency under combat conditions. Each trailer carries the following equipment: three heaters fired with oil, a high-temperature catalytic conversion chamber in which hydrogen and carbon dioxide are formed by the reaction of water and alcohol, four pumps, three blower fans, and a high-pressure compressor—all powered by a 50-hp. gasoline engine by means of a compact system of belt drives. The cooling medium is air rather than water, which might not be readily obtainable in remote locations, and is blown over finned coils. Along with each unit go spare parts and supplies that permit its operation in an isolated area for a year. These are numbered for quick identification and, like the equipment itself, are protected before shipment by the application of a rust inhibitor.

The rolling gas plant on its 12-wheel trailer is approximately 23 feet long, 8½ feet wide, 11 feet high, and weighs about 36,000 pounds. It will serve to generate hydrogen for barrage balloons used to discourage low-level bombing attacks and strafing sorties, as well as carbon dioxide for fire-fighting, for medicinal purposes, and for making carbonated beverages. The latter gas is compressed from 35 to 1300 pounds per square inch, thus permitting cylinders to be charged under adverse temperatures. The machine utilized for this work is an adaptation of Ingersoll-Rand's Type 40 air compressor the regular cylinders of which are replaced by three specially constructed single-acting cylinders, one for high pressure and two for low pressure.

Compressed Air Gives Flame Thrower Long Range

AMERICA'S new M1-A1 flame thrower is a deadly weapon that can shoot around a corner almost at a right angle and has a maximum reach of 180 feet, as against 60 for the older type. It is a strange-looking gun with a crooked barrel connected by flexible tubing to three cylinders strapped on the soldier's back. The two outer ones contain the "ammunition," while the middle one is charged with compressed air that forces the fuel into the barrel and sends it flying like a tracer bullet toward its objective. At the muzzle is a burner to which hydrogen gas is fed from another smaller cylinder attached to the underside of the barrel. This gas is electrically ignited. The fuel tanks have to be refilled in the rear where the necessary safety precautions can be observed.

Two men are required to handle the thrower, one to carry it and another to operate the valves that regulate the fuel and the air supplies. It is fired from the hip and burns Gel Gas, a thickened gasoline that issues from the muzzle in a rod-like stream. As it travels along at high speed the outer surface is ablaze; but the core is consumed progressively and is still in a semisolid state when it strikes the target. Even at the maximum range, impact is so great as to cause the burning Gel Gas to spatter and to adhere to whatever it comes in contact, quickly reducing everything combustible to ashes. The gun is usually fired in a series of 2-second bursts, as a sustained one would last only fifteen seconds. The complete equipment weighs 68 pounds and has been used with telling effect in the Japanese and European theaters of war.

Slime Formation in Dams Offset by Dehumidified Air

REFRIGERATION as an effective agency against slime formation in massive concrete dams and powerhouses is reported by S. O. Harper, chief engineer of the U. S. Bureau of Reclamation. The inspection galleries of these structures must be ventilated, and in humid weather the temperature inside is appreciably below the dew-point temperature of the air drawn in from the outside. As a result of this variation, moisture condenses on the gallery walls and on the electric and other machinery in the dam. Moisture accelerates the growth of microscopic organisms and the formation of slime, which soon cause considerable damage such as the deterioration of paint, the corrosion of exposed metal surfaces, and the breakdown of insulation on electric wiring and equipment.

It has been found that moisture condensation and its harmful effects can be avoided by dehumidifying the ventilating air before introducing it into the galleries, and equipment for this purpose is now being set up at Marshall Ford Dam in Texas. Another installation is proposed for Grand Coulee Dam in Washington. In both of these, provision is made for the use of refrigerating machinery, which is not available today because of wartime restrictions. At present, the air will be filtered and circulated through extended-surface coils, where it will be precooled by reservoir water. Later, it will be further cooled in the same manner but with refrigerated water. In its passage through the coils, the entrained moisture is extracted from the air through condensation. When thus dehumidified, the air will be circulated through coils exposed to warm water to bring its temperature up to that of the air within the galleries. So processed, a centrifugal blower will force the ventilating air into the passages.

Gas Company Puts Brushing Wheels to Novel Use

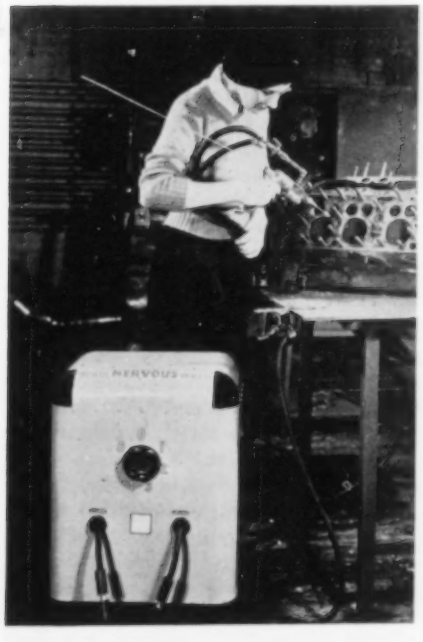
A RADICAL departure from the conventional uses of brushing wheels has been conceived and put into practice by the Southern Counties Gas Company of Los Angeles, Calif. According to The Osborn Manufacturing Company, producer of power brushes, each of the service trucks maintained by the public utility carries ten shut-off plugs, two each of 4-, 6-, 8-, 10-, and 12-inch diameter, to meet the requirements of the varying pipe lines. These are inserted in the gas mains in case of fire which, if left unchecked for any length of time, might endanger the entire system. Unlike steel pipe, which can be closed by hydraulic jacks in an emergency, cast-iron pipe will fracture under the excessive pressure exerted by them and therefore requires a different sealing method.

The plugs used for the purpose consist of a rubber stopper flanged by fiber plates and having a wire brushing wheel with a disk center section on each side. It is screwed on a piece of 2-inch pipe, 20 feet long, by which it can be inserted into a broken gas line without endangering the worker. The brushes serve as dampeners—as a means of absorbing the heat from the flames, and in that capacity add measurably to the effectiveness of the rubber stopper.

Defective Aluminum Castings Made Sound

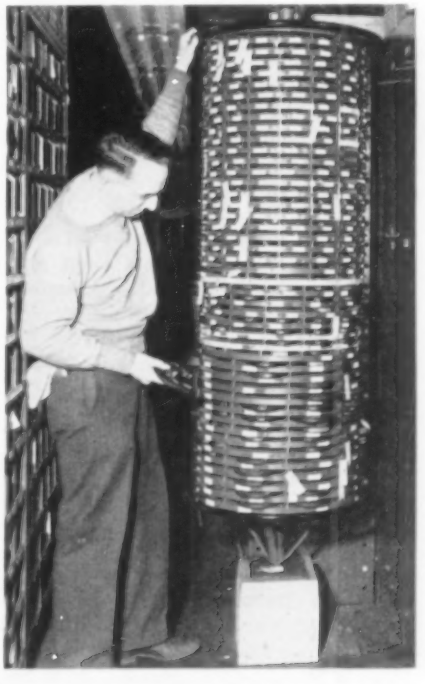
WHAT is described as a revolutionary and positive method of salvaging defective aluminum castings has been developed by the Metallizing Company of America. The process has had extensive practical application, we are told, and may also be used for reclaiming bronze, grey-iron, malleable, and steel castings, for building up surfaces for press fits, for repairing cracked housings and motor blocks, etc. The work is done by a Mogul Nervous Weld Pistol, using compressed air at approximately 60 pounds pressure, and by a Mogul Nervous Weld Machine which operates on standard single-phase, alternating-current voltages.

The pistol consists of a power chamber and peening motor, an air-cooled nozzle which keeps the electrode as well as the work cool, a needle valve that regulates the air supply, and of a finger trigger that feeds the metal rod. The latter is advanced from ⅛ to ⅜ inch with one stroke of the trigger and is deposited by the pistol in atomized particles that are welded to the surface and pressed in place. It is claimed that the temperature of the casting never rises above 125°F., which precludes the possibility of stresses, distortion, and warpage, and that the deposit is so dense at the point of fusion (within 1 to 1½ percent of that of the cast aluminum) that there is no apparent line of demarcation. This is not the case when working with bronze or nickel because of the difficulty of matching the parent and the weld metal, but the slight discoloration in no way affects the quality of the fill-in. Aluminum castings salvaged by this method are said to machine perfectly and to withstand the sodium hydroxide solutions used in preparing them for aluminite plating.



REPAIR WORK

This picture shows a cracked motor block being repaired by the new process. The Mogul Nervous Weld Machine is in the forground. It is a low-voltage, high-amperage unit with 1-dial control. Note the metal rod projecting from the pistol. It is fused by an electrode and atomized and applied by compressed air.

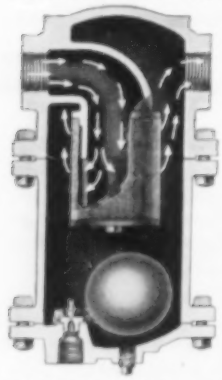


SAVES SPACE

This revolving tier of closely spaced wooden shelves has solved the problem of storing snap gauges at the Fort Edward plant of the General Electric Company. It is provided with pipe rails top and bottom, and ball bearings permit it to be swung easily around a central iron pipe. The rack holds 400 gauges. Each has its own labeled compartment to which a tag is attached when it is issued.

Industrial Notes

Johnson Corporation has announced the development of a self-draining compressed-air separator that is based on the same operating principle as its standard units. The entering air is first allowed to expand slightly so as to precipitate most of the entrained moisture.



Then it passes through a labyrinth of coarse wire mesh where its direction of flow is abruptly changed many times and where it surrenders any remaining particles of foreign matter. Drainage is effected automatically by a built-in trap mechanism with a spherical float and a chrome-steel valve. When the level of the liquid in the bottom of the separator body is high enough to raise the float, the valve opens, permitting the water, oil, etc., to flow out. The Johnson SA separator comes in two sizes with inlets ranging from ¾ inch to 2 inches and with capacities of 80 and 160 cfm. at 90 pounds pressure.

Waferthin, microporous rubber is serving in place of wood as separators in storage batteries. They are said to last five times as long, and permit charging at point of manufacture so that batteries are ready for use as soon as acid and distilled water is added.

Concrete stronger than steel and lighter than aluminum has been produced by engineers of Northwestern University of Evanston, Ill., according to a recent announcement by the department of civil engineering. The material is compressed in spiral steel wiring and is said to cost only one-third as much as steel. It was developed as a substitute for structural-steel columns.

Phenolic parts of communications and other electrical equipment in tropical countries can be protected against fungus, it is claimed, by coating them with Durad No. 524, a varnish that has been compounded for that purpose by Maas & Waldstein Company. It is applied by brush, dipping, or air spray and has, it is reported, passed all tests for dielectric strength, hardness, flexibility, and resistance to salt spray and thermal shock.

Interchangeable table tops to meet working requirements and adjustability are features of a new table called Rightop. The top can be raised and lowered by turning a crank and can be tilted at any angle to assure anyone a comfortable working position whether sitting or standing. As many as twelve different tops are available and may be kept in a special rack when not in use.

To protect the inlets of condenser tubes against the erosive action of air and the abrasive action of sand, the Crane Packing Company has designed a member that fits inside the inlet end and provides a bell-mouthed venturi entrance for the circulating water. The Protector is molded of hard Bakelite that is not affected by temperatures up to 275°F., and is resistant to contaminated salt or fresh circulating water. It is cemented in place and is made for marine and stationary power-plant condenser tubes of the following sizes: ⅝ and ¾ inch, 16 and 18 gauge, ⅞ and 1 inch, 18 gauge.

Tin cans that are food containers and heaters in one enabled Allied troops to have hot rations soon after the invasion of the Normandy beachhead. They are the product of the H. J. Heinz Company and of Imperial Chemical Industries and can be raised to a temperature of 160° in about five minutes. The heating compound is contained in a centrally disposed tube and can be ignited with a match or cigarette. The new container weighs four ounces more than the standard 16-ounce can and holds 2 ounces less.

For use in confined spaces, James H. Knapp Company is making a compact little rivet-heating forge fitted with lifting hooks so it can be moved readily even when hot. The heating space is 8 inches in diameter and 7 inches deep and has a chrome-refractory bottom lining that will not slag with rivets. It is designed to permit easy charging and removal of rivets without discomfort to the operator. The unit comes complete with burner and control valves and is fired with compressed air and natural gas. It is also made to burn light oils.

An improved type of retriever hose reel for industrial use has been put on the market under the name of Wayne Retriever. Features claimed for it are an automatic spring that permits free unwinding and quick rewinding; a ratchet clutch that holds line at any desired length until released by a short forward pull; automatic braking action which prevents whip and runaway; and a universal bracket by which reel can be mounted on ceiling, wall, or floor, or in any central position to serve several operators or tools. The Wayne Retriever is made in four models for 12-, 18-, and 50-foot lengths. Obviously, reels of this type prolong hose life and avert accidents because they are never under foot when not in use.

We have learned recently that the coffee bean is a source of plastics. Now it is reported that it contains fuel and lubricating oils, hydrogen, phenol, and six other chemicals. A Swedish chemist is responsible for the statement, and has patented a process for the extraction of the various products. Experiments in a special laboratory have shown that 4400 pounds of coffee will yield 392 pounds of fuel oil and 672 pounds of lubricating oil, in addition to the other constituents.

Reporting on the use of flotation tailings as a stope-filling material in a Kalgoorlie gold mine, the Department of Mines of Western Australia says: The tailings were thickened to contain 65 percent solids and were run through a 2-inch pipe line to the respective stopes prepared for the initial layer by placing canvas on the compacted rock and packing the manway and ore chute with old

sacking to prevent leakage. No trouble was experienced with water, which was conveyed to a settling tank and pumped to the surface. At the expiration of 48 hours the tailings settle sufficiently to permit the resumption of drilling operations. With this system, when perfected, the company expects to fill stopes at one-quarter the cost of dry filling.

Wheels that have great tractive force on snow-covered roads have been invented in Switzerland and are being made in Sweden, according to a recent issue of *Foreign Commerce Weekly*. Known as the Meili S, they are described as a steel-spring type of wheel without the conventional rubber tire. Each has two sets of S-shaped springs: an outer one that adapts itself to the contours of the traffic lane and an inner set that takes the weight of the vehicle. The wheels have been used successfully on trucks carrying loads of 4.4 short tons and driven at a speed of 40 miles an hour over snow-covered forest trails that trucks with rubber tires and chains could not negotiate.

G. I. Joe's drinking water will soon be better protected against insects, dirt, and germs because of the development of a sterilization bag that is based on the principle of the ancient Arabian desert water bag. It is made of a heavy semi-porous duck covered with a synthetic resin and permits of slight seepage to keep water cool at all times through evaporation. The carrier holds 36 gallons and has five Bakelite taps approximately 2 inches above the bottom so that any sediment that may find its way in will be below the faucet line. The bag was devised by the Army and is being manufactured by the United States Rubber Company. It will be used in all battle areas as soon as deliveries can be made.

Information on the frost resistance of building stones is made available quickly and economically, it is claimed, by a new laboratory process that depends for its effectiveness on dyes. According to *Highway Research Abstracts*, specimens of the material are dried at a temperature of 230°F. until the weight is constant, after which they are immersed for 24 hours in a 4 percent solution of nigrosine in methyl alcohol. Durability is determined by the depth of penetration, 0.02 inch representing 100 percent resistance. In all but one series of tests there was agreement between the results obtained by the nigrosine method on the one hand and by freezing and thawing on the other. Cracks were made visible by the dye that could not be detected with a magnifying glass, and many natural stones were found to be more frost resistant than they are generally supposed to be.

NEW AERO *After Cooler*
GIVES DRY COMPRESSED AIR
and saves cooling water

● Compressed air experts say that using more thoroughly dried air would save air tool users thousands of dollars in repairs and thousands of hours in lost time. In many industrial processes, drier air will prevent loss of valuable materials or rusting of delicate parts.

The NIAGARA Aero AFTER-COOLER offers a new method—the application of *evaporative* cooling—which makes possible lower air temperature and compressed air that is drier, safer to use for any purpose. It also provides closed circuit jacket water cooling with the Niagara "Balanced Wet Bulb" temperature control, preventing condensation and the washing of lubricating oil into the air lines.

In operation, it saves 95% of cooling water consumption, paying for itself in saving water cost. Write for Bulletin 98.

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

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WALWORTH No. 95
BRONZE GLOBE VALVE
Where throttling is *not* required

Improved lock-on, slip-off disc holder. Re-new disc. Union bonnet for extra strength.

Non-heating hand-wheel. High quality bronze body casting. Screwed or flanged ends.

WALWORTH No. 245 P
BRONZE GLOBE VALVE
Where throttling is required

Removable seat and disc. Hard copper-nickel discs. Stainless steel seat rings.

Non-heating hand-wheel. High quality bronze body casting. Screwed or flanged ends.

Both of these popular Walworth Bronze valves are recommended for general service – No. 95 where throttling is not required, No. 245P where frequent throttling is required. No. 95 is rated at 150 pounds steam pressure. Its improved renewable disc and lock-on, slip-off disc holder – originally developed by Walworth – saves time and trouble. No. 245P, rated at 200 pounds steam pressure, features extra hard discs and seat rings that are highly resistant to abrasion, erosion, wire-drawing, and galling. These Walworth quality valves Nos. 95 and 245P are made of the high-grade bronze known as Navy Composition M.

These valves are famous for their economy and long, reliable service. In design and construction they reflect the unusual sturdiness and efficiency of all Walworth Valves, the result of "know-how" gained by more than a century of valve manufacturing experience.

For further information on Walworth's complete line of valves and fittings get in touch with your Walworth distributor, or write for a free copy of Catalog 42.

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Ten-ton tire

A typical example of B. F. Goodrich product development

A TIRE like this weighs only a *third* of a ton but can carry a *load* of *ten* tons, forty tons or more for four tires — nearly as much as a freight car. It is used for off-the-road hauling. It holds as much air as 25 auto tires, takes 20 minutes to inflate, costs $750.

The Pennsylvania Turnpike, finished five years ago, might still be under construction if there were no big tires like this. Dams and airports now finished in 18 months would probably take four and five years to build. But even with all their advantages, costs were too high because these tires, running over big rocks, bruised too easily. Inner cords broke under sharp impact; tires had to be repaired or thrown away. Time and money were lost.

Then B. F. Goodrich men developed a new kind of "bruise-protected" tire. It has four extra layers of cords embedded under the rubber tread, and with a special kind of rubber between them. Under impact the cords distribute the force of the blow and allow it to be absorbed by the rubber.

Contractors tried the new tires. Some of the records were: 17,226 miles against 12,501 for the best of all three ordinary tires used; 15,017 miles compared to 11,304 for the best ordinary tire; 17,599 miles compared to 6,476 for the best ordinary type. There would be even more such records if military needs permitted more contractors to get these new tires.

B. F. Goodrich developments extend to every type of tire — passenger car, truck, airplane, farm, industrial, and the big off-the-road type. Whatever your tire need, if you buy B. F. Goodrich, you get tires backed by this policy of constant improvement.

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Truck & Bus Tires

ACHIEVEMENT

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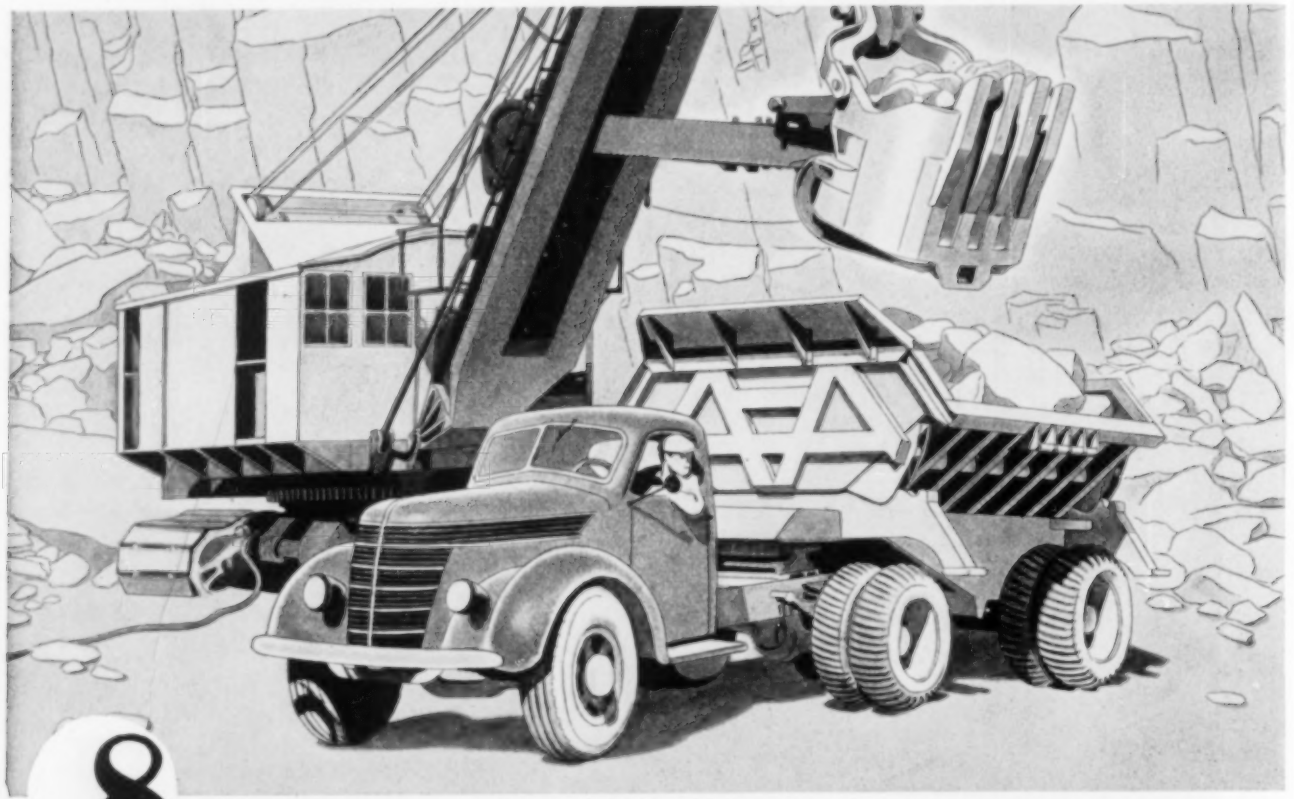

Unknown 8 *Years Ago . . .* **Semi-Trailer Haulage Today Moves 40 Million Tons** *Annually*

When EASTON engineers were asked to build the first semi-trailer for quarry haulage eight years ago, the idea was new, untried, challenging. The first units were notably successful because EASTON had a background of achievement in solving quarry and mine haulage problems. And those pioneering Models RP-8 and RP-10 are today still in use and doing their part to swell to forty millions per year the tonnage of rock and ore loaded safely, hauled cheaply and discharged efficiently from side dumping EASTON Trailerized Mine Cars.

Write to: Engineering Counsel, Easton Car & Construction Co., Easton, Pa.

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ELECTRIC LIFT TRUCKS

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1 Model TR-15D—Double bodied, 15 to 20 ton capacity for use where crusher size or hopper length is limited.

2 Model CW—Thirty ton iron ore hauling overhead hoist side dump truck body.

3 Model TR-15T—Tandem "monkey" axle running gear with 80,000 pound capacity overhead hoist dump trailer.

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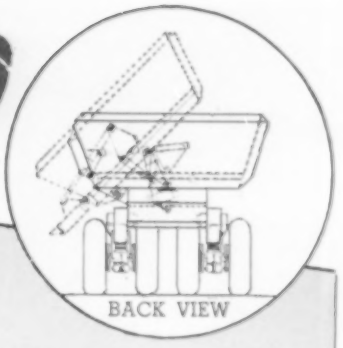
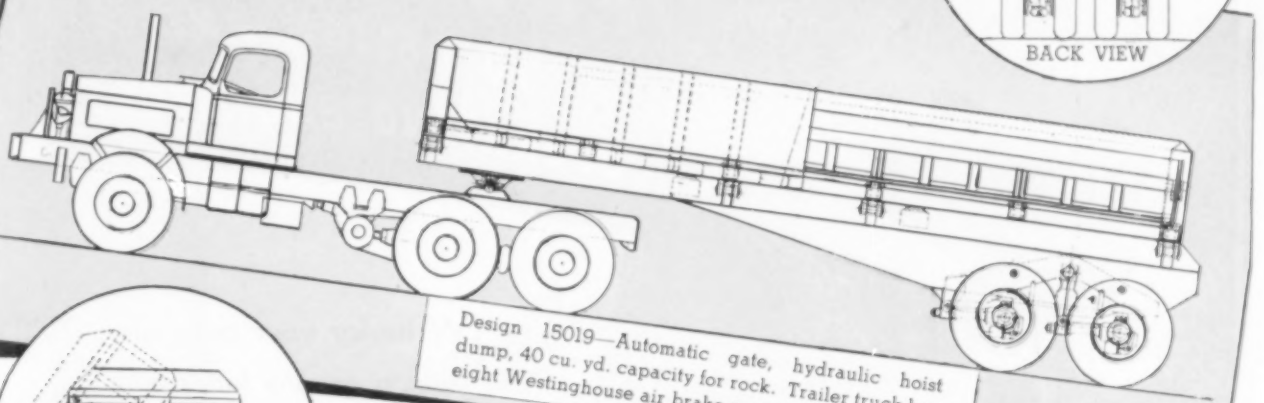
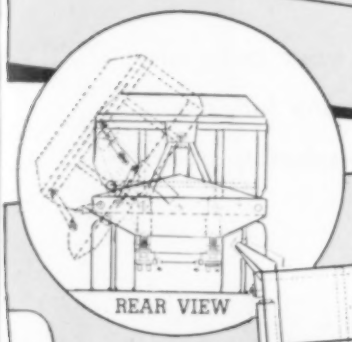
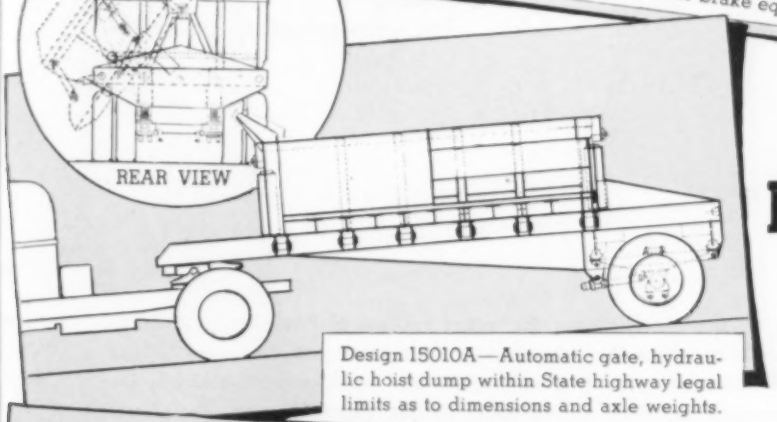


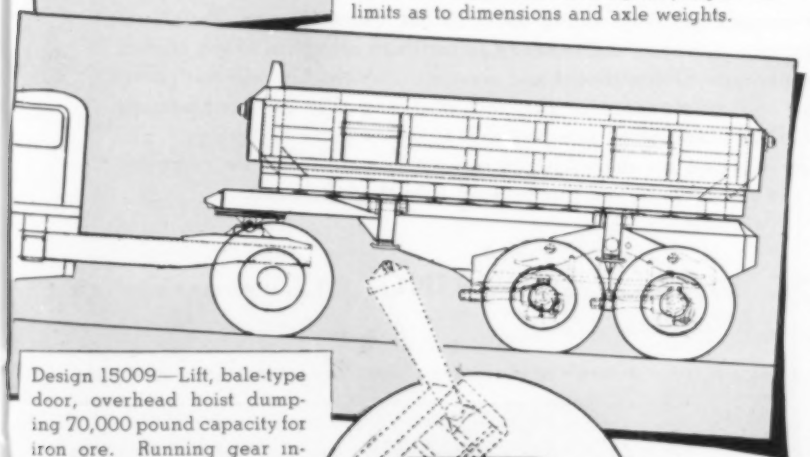


Design 15019—Automatic gate, hydraulic hoist dump, 40 cu. yd. capacity for rock. Trailer truck has eight Westinghouse air brake equipped wheels.

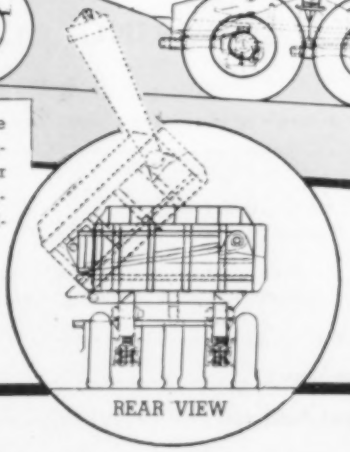




Design 15010A—Automatic gate, hydraulic hoist dump within State highway legal limits as to dimensions and axle weights.



Design 15009—Lift, bale-type door, overhead hoist dumping 70,000 pound capacity for iron ore. Running gear includes eight independent full-floating, sprung wheels.



for
BIGGER PAYLOADS

Tomorrow's production will require bigger crushers, larger shovel dippers, longer hauls with bigger payloads. EASTON engineers are planning equipment to keep pace with rapidly changing trends for moving economically all types of ore, trap rock and limestone.

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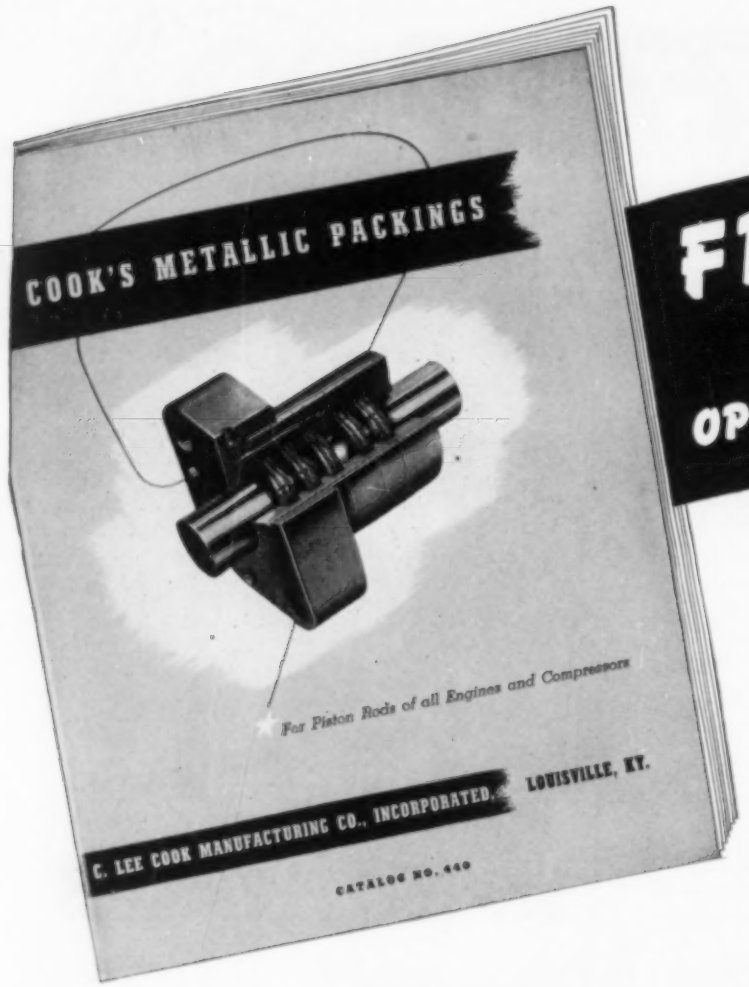
TRUCK BODIES · TRAILERS
ELECTRIC LIFT TRUCKS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When gas engines backfire, the force of gases rushing out through the air intake is tremendous. So great, in fact, that an ordinary air filter might be blown hundreds of feet away. To overcome this dangerous condition, Air-Maze engineers have incorporated a *backfire relief valve* as an integral part of their oil bath filters to permit rapid escape of backfire gases.
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More helpful than ever, now that war deferred maintenance must be reckoned with, Crane *complete* piping materials service simplifies every step of piping rehabilitation. One reliable source—your Crane Branch or Wholesaler—supplies everything you need, be it a single fitting or a complete new system. In brass, iron and steel materials for all power and process piping applications, the Crane line provides the world's most comprehensive selections.

One order to Crane covers all your requirements for any job. One responsibility for the quality of all parts helps assure the best installation. But mainly, by always specifying Crane materials, you get full benefit of 89 years' experience and leadership in meeting industry's piping needs.

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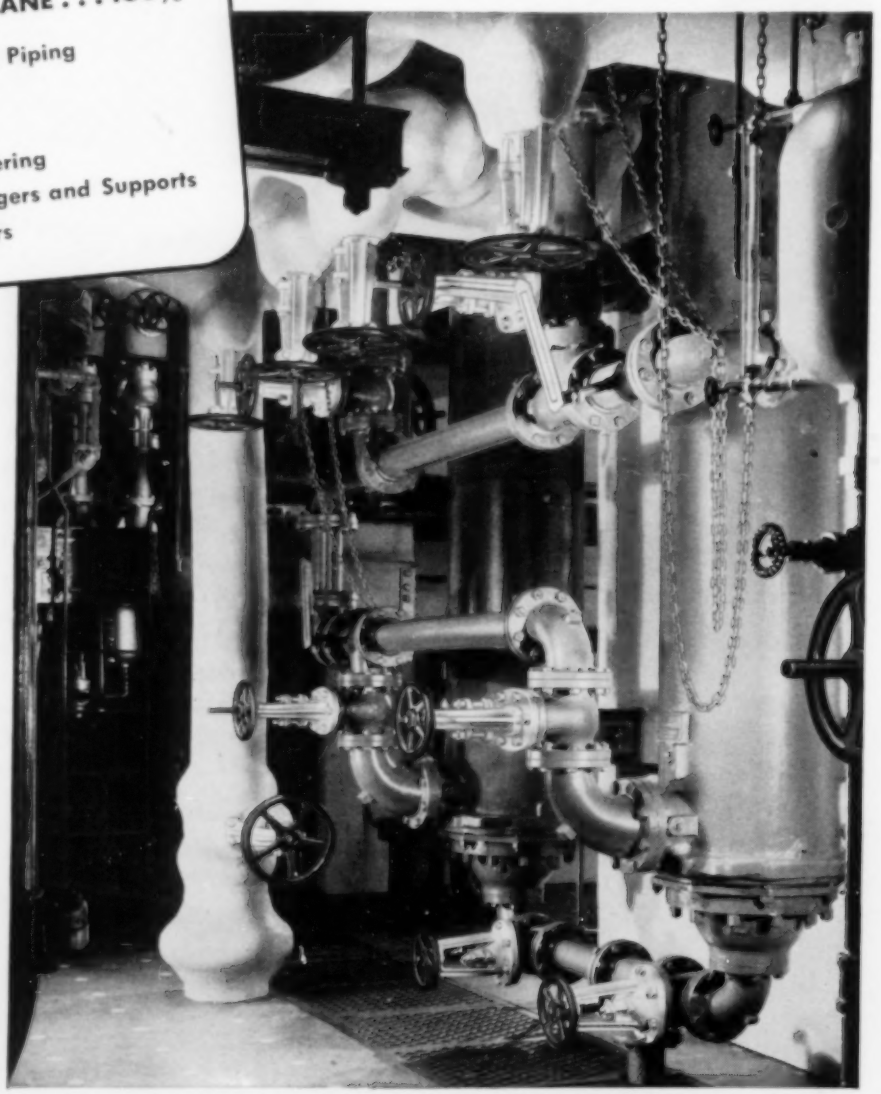
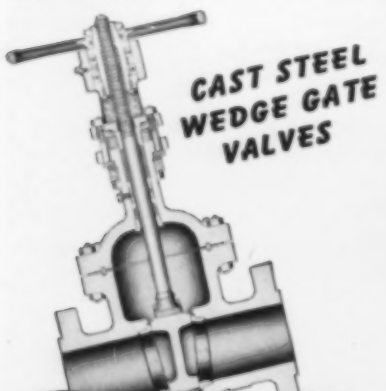


Installation in Industrial Power Plant

ONE STANDARD OF QUALITY

The same high quality protects every part of piping systems when Crane materials are used throughout. In Crane Steel Gate Valves, for example, straight-through ports permit unrestricted flow. Severest line stresses are overcome by sound and rugged body castings. Smooth operation is maintained by a ball joint type stuffing gland, strong tee-head disc-stem connection, and ample stem bearings. Positive seating is assured by extra long disc guide ribs.



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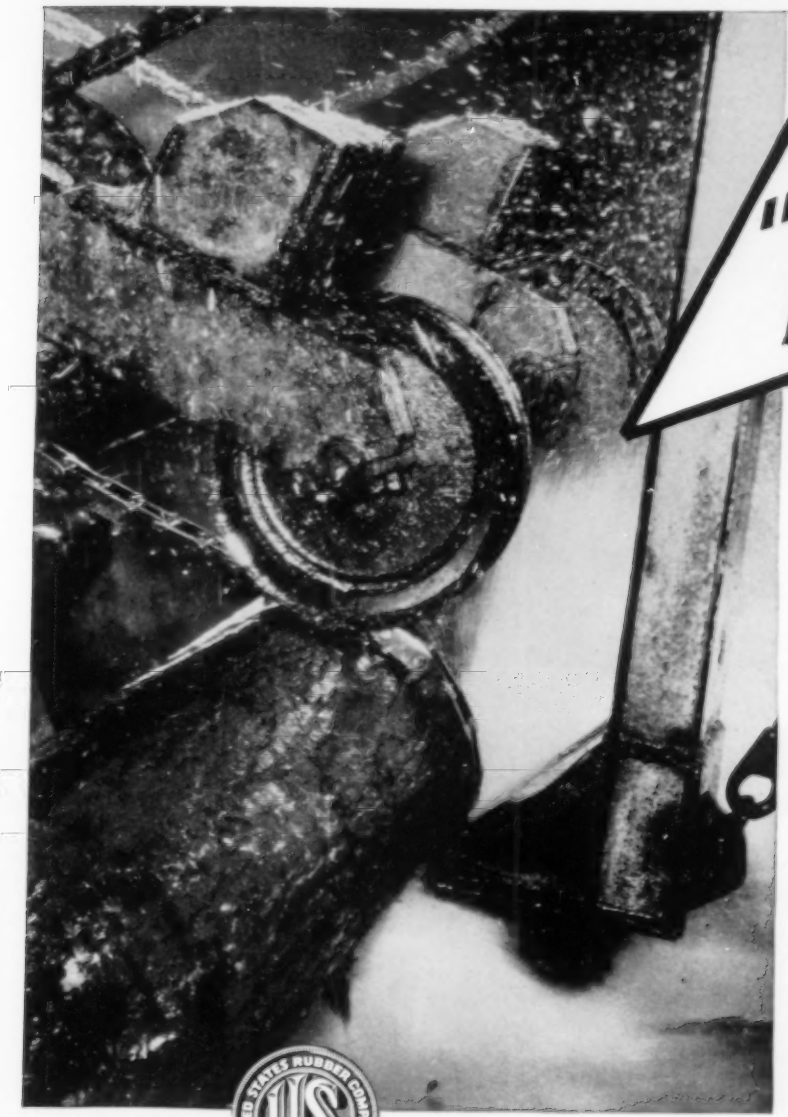
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS



"RAZOR" OF WATER

SO SHARP IT CAN STRIP A 20-FOOT LOG IN LESS THAN 30 SECONDS

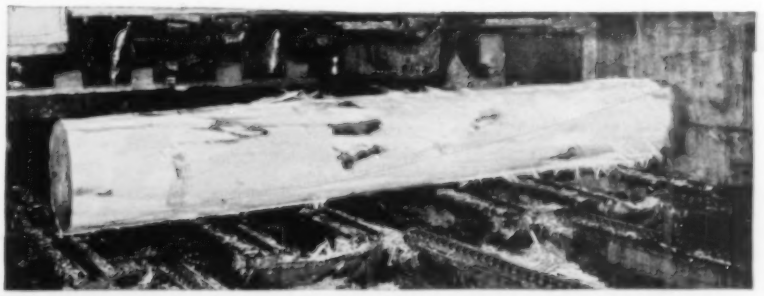
Imagine stripping a log of its bark with jets of water! Yet that is the latest method of de-barking pulp logs.

Two jets of water spurt from nozzles mounted on a mobile carriage. And so great is the pressure (1400 pounds per square inch) that if the to-and-fro movement of the nozzles were slowed down, holes would be bored in the log!

To apply this terrific power, U. S. Rubber Company developed flexible, wire braided high-pressure hose of 1½-inch diameter. This hose, a vital part of the de-barker, was flexed over a million times in tests, to make sure it could withstand the great strain and swift movement required. Under continual high pressure, the hose takes gruelling punishment, yet never fails to maintain the accurate, steady performance required to de-bark logs quickly, cleanly, economically. Hose for de-barking is one of the many examples of U. S. Rubber Company's ability to engineer rubber products for every requirement, for each specific job.

SERVING THROUGH SCIENCE

HIGH-PRESSURE HOSE—(U.S. Style P-7532) carries water to nozzles under 1400 pound pressure. Great flexibility is essential as the sprays move back and forth along the rotating log.

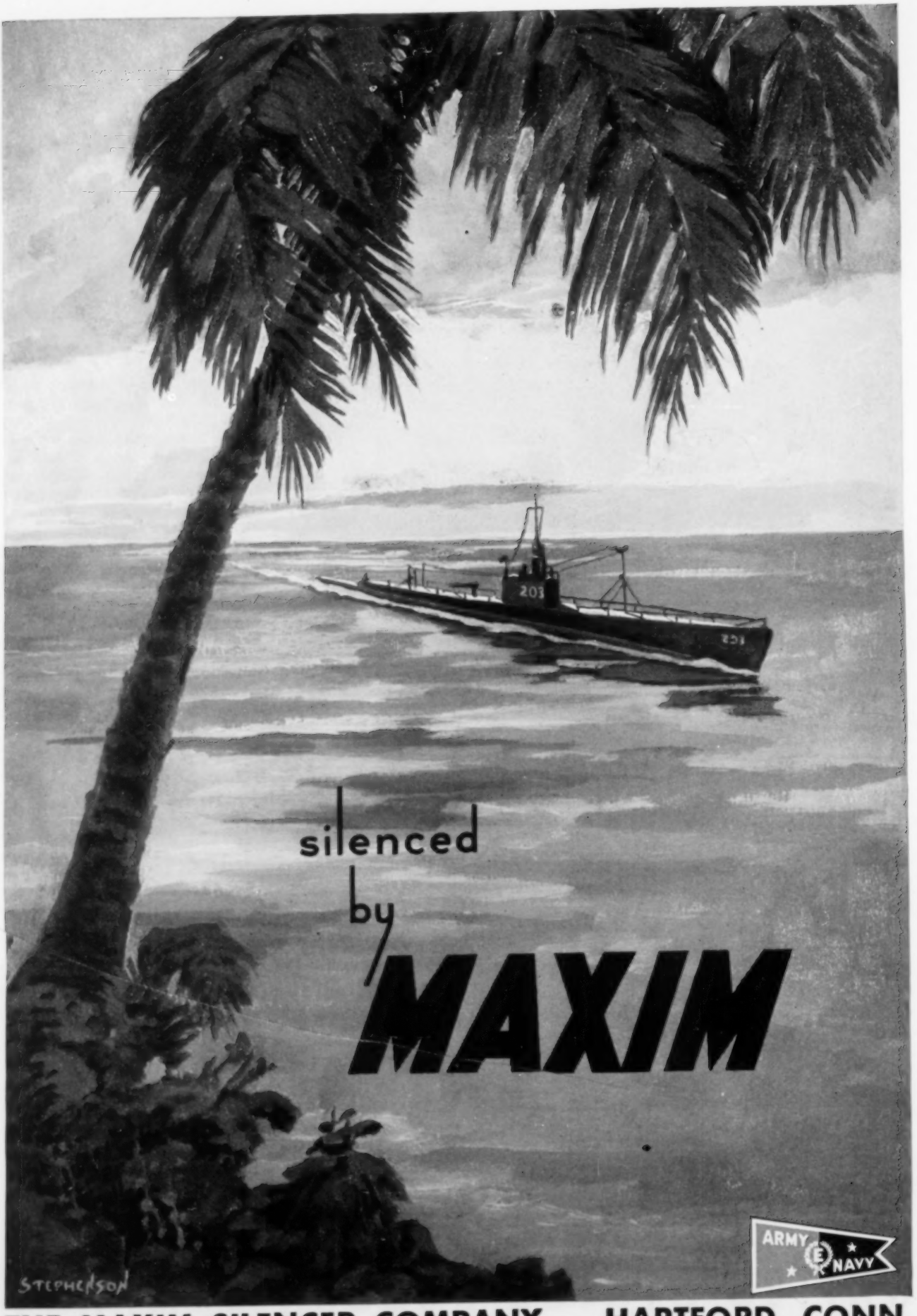


DE-BARKED LOG is shown here ready to be chipped. It is reported that use of the Hydraulic De-Barker using U.S. Wire Braided Hose results in an 18 to 20 per cent saving in pulp and permits the production of chips with one-fifth the manpower formerly used, and one-third the wood loss.

Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE • ROCKEFELLER CENTER • NEW YORK 20, N. Y. • *In Canada:* DOMINION RUBBER CO., LTD.



THE MAXIM SILENCER COMPANY . . HARTFORD, CONN.

ROLLING KILOWATTS

FIRST AID FOR WOUNDED COMMUNITIES

Picture a town with its power plant knocked out by shell-fire or "scorched earth." Groping in darkness, unable to use sorely needed facilities, it is a grievously stricken place, easy prey to accidents and disease. Recovery is slow and difficult, for it may take as long as two years to rebuild a destroyed power plant.

But now the rehabilitation of war-wounded communities can be greatly hastened by a new idea—rolling kilowatts, a power plant on wheels.

Within a matter of hours after arrival, this novel train can be generating enough electricity for a sizeable community. It will operate efficiently in 40 degrees below zero or 110 degrees above—on low grade coal and a meager water supply.

Ten such trains, each rated at 5,000 kilowatts, are being built by Westinghouse with boilers supplied by Combustion Engineering. They are the highest capacity power trains for overseas service.

In fitting the boiler equipment into railroad cars of ordinary size, many unusual engineering problems had to be solved. These involved allowable car weights, axle loads, railroad clearances and similar limitations.

★ ★ ★ ★

The ability, resourcefulness and experience reflected in the solution of these difficult problems is available to you now in planning your peace-time steam needs. Whether your requirements are large or small, simple or complex, C-E equipment will assure you a dependable source of low-cost steam. A816

COMBUSTION ENGINEERING

200 MADISON AVENUE NEW YORK 16, N. Y.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

bringing up the BIG GUNS

OFFICIAL U.S. ARMY PHOTOGRAPH

TWIN MODEL 145-GZ WAUKESHA ENGINES power the new 38-ton High Speed Tractor M-6...big brother to the M-4 which has a single Waukesha Engine of the same model. The engine is designed and built by Waukesha Motor Company, and both tractors are designed and built by Allis-Chalmers in co-operation with the Army Ordnance Department.

...WITH WARTIME WAUKESHAS!

First things *first*... and first things *fast*. To our American artillerymen that means superiority of fire power—and moving up the big guns in a hurry!

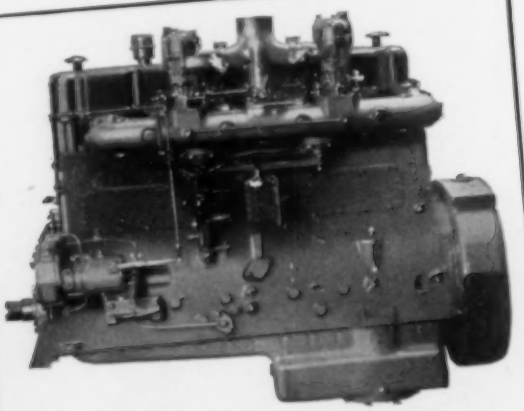
The giant artillery tractors start rolling. Powered by wartime Waukesha Engines... no road is too rough... no terrain too tough. Up come the 8-in. guns and the 240 mm. howitzers... into position... and it's all over but the shooting...

American fire power, amazingly accurate and deadly destructive, pounds the enemy defenses to pieces. It's all deeply depressing to enemy army morale.

No ordinary engine gives M-6 and M-4 Military Tractors their power to pull—their smoothness and swiftness. It's a wartime Waukesha—Model 145-GZ—a super power plant built by Waukesha to outpower and out-perform any similar engine of the same size ever produced!

Every Waukesha Engine will be a wartime engine, until V-Day. Then there'll be Waukesha peacetime engines for your special requirements. Write Waukesha engineers now about your future engine needs.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES



MODEL 145-GZ WAUKESHA ENGINE

Six cylinders, 5⅜ in. bore x 6 in. stroke, 817 cu. in. displ. Burns gasoline... is designed to use modern aviation fuels... develops high output. And it's really rugged! Crankcase and cylinder block cast as a single unit. Crankshaft is drop-forged steel, heat treated. Wet sleeve cylinders easy to remove and replace. Positive pressure oiling with built-in oil cooler. Thermostatic by-pass system maintains efficient operating temperatures, and assures quick warm-up when starting.

MORE POWER FOR VICTORY

WAUKESHA ENGINES

First in War, First in Peace—

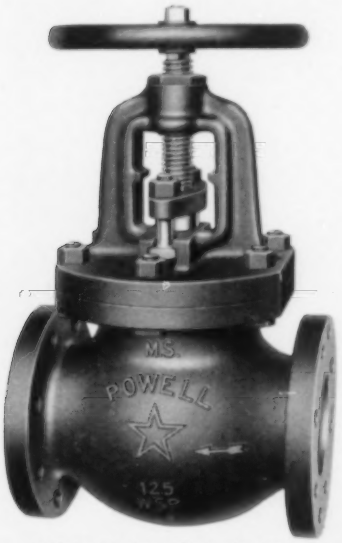
There's always a POWELL Valve for every requirement of Industry.

The "KNOW-HOW" acquired through 98 years of making valves—and valves only—has enabled POWELL Engineering to design valves to meet every problem of wartime flow control. This same "KNOW-HOW" is your assurance for the *post-war* future. Shown here are a few examples of a complete POWELL Line especially adapted to your industry. As new requirements arise, there'll be POWELL Valves to meet them.

The Wm. Powell Company

Dependable Valves Since 1846

Cincinnati 22, Ohio

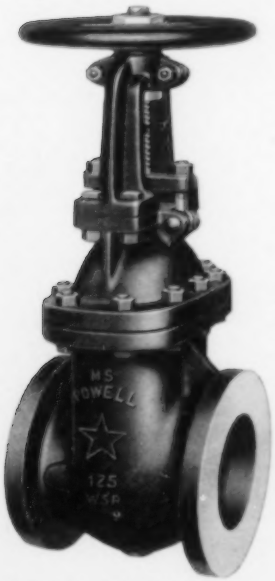


125-pound Iron Body Bronze Mounted O. S. & Y. Globe Valve with Vulcanized Composition Disc.

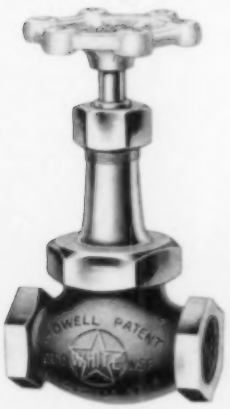
200-pound Bronze Gate Valve with renewable disc.

150-pound Iron Body Bronze Mounted Swing Check Valve with Vulcanized Composition Disc.

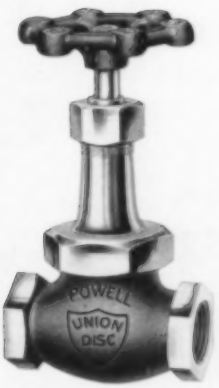
200-pound Bronze Dash Pot Check Valve.



125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.



200-pound Bronze Globe Valve with regrindable, renewable seat and disc.



150-pound Bronze Globe Valve with Composition disc.

125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Globe Valve.

POWELL VALVES

New

New

KIPP
Featherweight
AIR GRINDER

The Model JA is new in design both inside and outside. In it are utilized fewer parts, and they are made of Magnesium and Aluminum for extreme featherweight lightness. The alloy steel shaft diameter is unusually large for sustained smooth and true operation. This means still longer wheel life and better grinding. The speed, as before, is governed at 50,000 R.P.M. and there are selected ball bearings, front and rear. The JA Featherweight is a distinct improvement over all models previously produced by Madison-Kipp, the originators of really high speed grinders.

The same low price, $29.75 in U.S.A., remains. It is a post-war design for which materials have been released early. The pre-announcement output was geared to expected demand. Deliveries will be made out of stock as long as possible.

MODEL JA

50,000 R.P.M.

$29.75 in U.S.A.

NOTE:—Higher speeds at higher prices are available if supporting engineering data are submitted. Higher speeds are not recommended unless properly supervised.

Weight 12 ounces; Length 6¾ inches; Chuck Size ⅛ inch.
Wheel Guard Removed for Better Illustration

by

MADISON-KIPP

Nearly everyone in the mechanical industries knows about or uses Kipp Air Grinders. The Kipp announcement nearly fifteen years ago of the first hand grinder which turned 40,000 R.P.M. was a welcome surprise to tool makers. They always knew mile-a-minute surface speed was needed to remove metal instead of excessively rubbing down grinding wheels with slower speeds. The Kipp Air Grinder was the solution to the long standing grinding problem of getting into small places with small wheels.

The new Kipp Featherweight Grinder was made ready for post-war production. It can be sold now only because Aluminum and Magnesium have been more widely released. This post-war product, designed to meet all comers, can therefore be used in the continuing war jobs and for civilian jobs whenever they can be started.

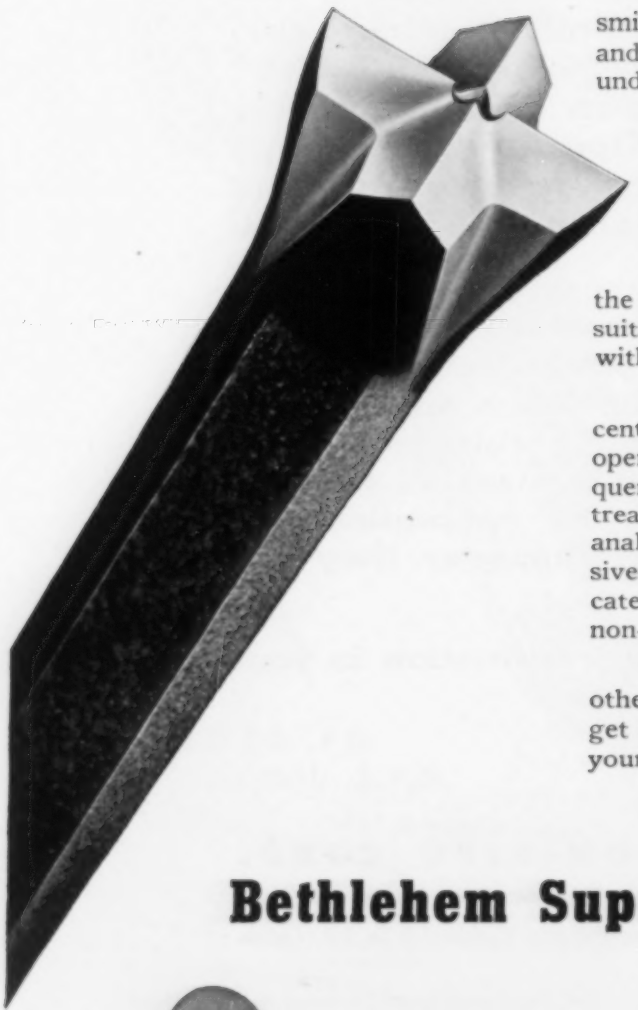
Please include priority information in your wire orders.

MADISON-KIPP CORP.

202 Waubesa St., Madison 4, Wis. U.S.A.

Sole Agent in England: Wm. Coulthard & Co. Ltd., Carlisle

Superior in Fact... as well as name



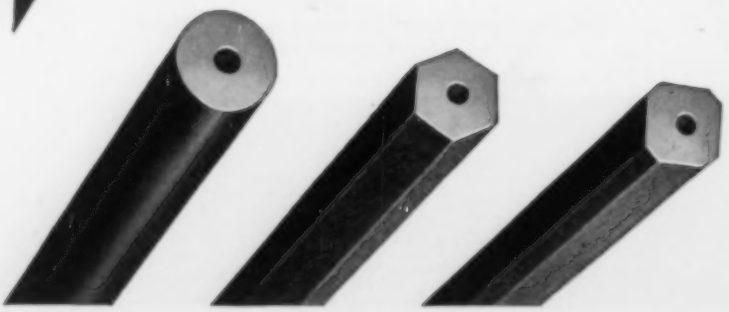
Because methods vary so widely in different blacksmith shops, a drill steel has to be foolproof. Its analysis and physical properties must be such that it will stand up under a variety of heat-treating and handling practices.

Bethlehem Superior Hollow Drill Steel meets this fundamental requirement—a fact that has been demonstrated time and again on some of the country's biggest mining, construction, and road-building projects. It's the sort of steel that demands no pampering or coddling; it's easy to work with, both on the job and in the reconditioning shop; and it's equally suitable for both forged-on bits and fabricated rods used with detachable bits.

Drill runners find that the smooth, round, well-centered hole through the steel contributes to speed of operation. Blacksmiths like it because its wide critical quenching range allows a substantial latitude in heat-treating requirements. And metallurgists know that its analysis and grain size assure a water-hardening, abrasive-resistant bit; wear-resisting threads when a fabricated rod is used; and an oil-hardening, shock-resisting, non-peening shank.

Perhaps you're already familiar with these and other advantages of Bethlehem Superior. If not, better get acquainted with this old favorite when you order your next lot of drill steel.

Bethlehem Superior Hollow Drill Steel



★ BETHLEHEM STEEL ★

What's Needed in a Pipe Joint Compound?

This enlarged, unretouched sectional view of a threaded pipe joint tells the story. Note large clearances at inner (left) end, and threads in close contact at the right.

For leakproof, non-seizing joints, choose a sealing compound which

- Readily fills all clearances and thread imperfections.
- Seals *permanently* — insoluble in fluids handled (water, oil, steam, gasoline, butane, refrigerants, etc.)
- Lubricates the threads to permit quick tightening.
- Protects the threads; prevents galling, rust and seizure.

John Crane PLASTIC LEAD SEAL does all of this. In addition, it never hardens — so joints stay tight under vibration and strain, yet are easily disconnected after years of service. Ideal for both production assembly and general plant maintenance. Sold in 1, 5 and 7 lb. cans, ready for use. Send for free test sample; use it on joints, plugs, studs and gaskets.

CRANE PACKING COMPANY

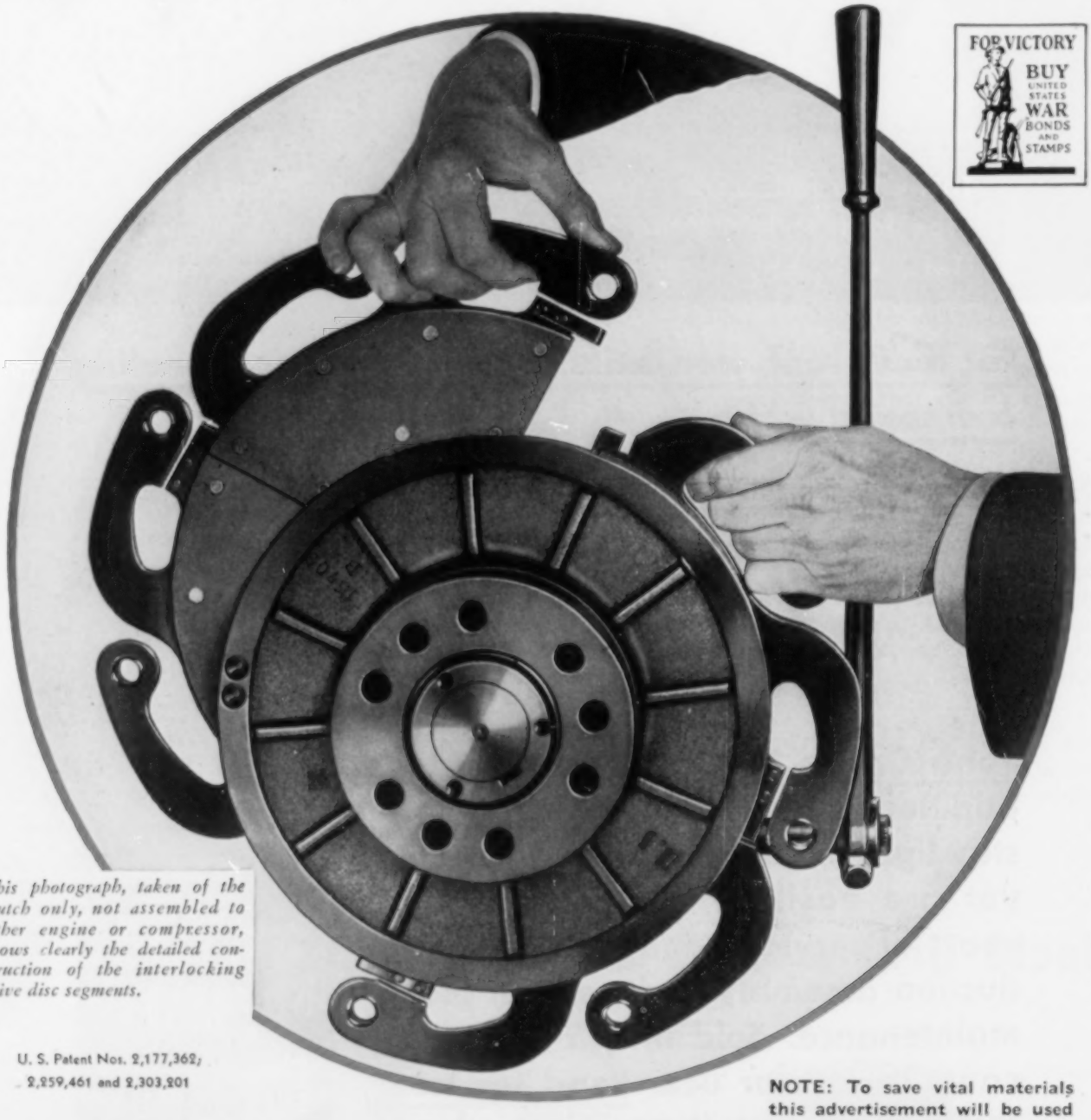
1808 CUYLER AVE. • CHICAGO 13, ILL.

BALTIMORE, BOSTON, BUFFALO, CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver

FLEX-DISC CLUTCHES

Used on the entire line of I-R *Mobil-Air* Compressors, have a time proven drive disc with flexible fingers solidly bolted to the fly wheel. When the friction facings become worn these drive discs, which are quickly detachable in segments, may be removed and relined or replaced without disconnecting the engine from the compressor.



FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362; 2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin

He sharpens 500 detachable bits a[illegible] day!

That sounds like a mighty big order, but the job is done every day by grinders who use *Aloxite* Wheels by Carborundum. In order to receive the maximum efficiency and production from detachable bits, it's necessary to get and *keep* a good cutting edge on them. These grinding wheels cut free and cool, and preserve the temper of the steel, so the bits can remain in service for longer periods.

Detachable bits reduce steel shop costs and nipping charges, and eliminate the need for taking steel in and out of working spaces. So you save time and labor, speed production, and cut drilling costs when you keep your detachable bits properly ground with Grinding Wheels by Carborundum.

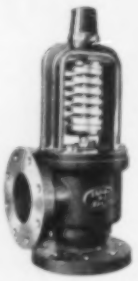
The Carborundum Company, Niagara Falls, New York.

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Buffalo, Pittsburgh, Cincinnati, St. Louis, Grand Rapids

Grinding Wheels by CARBORUNDUM TRADE MARK

(Carborundum and Aloxite are registered trade marks of and indicate manufacture by The Carborundum Company)

HIGH LIFT



A FEATURE OF *EVERY* FARRIS RELIEF VALVE

Open or enclosed spring liquid relief valves. Sizes: ¾" to 6" in steel, semi steel and bronze; pressures to 600 p.s.i.

High lift . . . which means prompt relief . . . is provided by the oversize springs in Farris Relief Valves.

Moreover, these springs have low fibre stress . . . low pitch . . . are mounted on flexible joints at both upper and lower points . . . and are carefully calibrated.

These are some of the features that give you dependable operation, long life, and low maintenance expense. Write for bulletin and complete information.

FARRIS ENGINEERING COMPANY

354 Commercial Ave. **Palisades Park, N. J.**

Wherever wire rope is fastened **STANDARDIZE** *on Genuine* **CROSBY CLIPS** *with the Red U-Bolt*

A safe, lasting and easy-to-put-on clip for every size of rope from ⅛-inch to 4-inch.

Sold by leading distributors everywhere

AMERICAN HOIST & DERRICK CO.

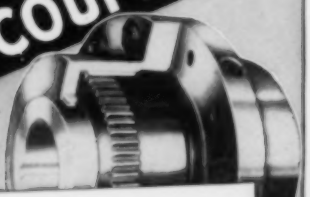
SAINT PAUL 1, MINNESOTA

CHICAGO SAN FRANCISCO NEW YORK

THE GENUINE *Crosby Clip* WHEREVER WIRE ROPE IS FASTENED

Specify **WALDRON** *Flexible* **COUPLINGS**

A TYPE AND SIZE FOR EVERY PURPOSE



Compare their design with that of any other coupling. No welding in forged steel cover and sleeve. No flexible hub connections to fatigue. No leakage through positive Walflex Seal. No added stress on shaft or bearings while compensating for misalignment. By eliminating the chief causes of wear and repair, you insure longer trouble free service.

Catalog containing construction details, rating tables, etc. will be sent on request. No obligation.

JOHN WALDRON CORP.

Main Office and Works

New Brunswick, New Jersey

COUPLINGS

You get DOUBLE PROTECTION with the Johnson Separator

Removes 99% Plus of Dirt and Moisture from Compressed Air

1. Air expands slightly—precipitating most of moisture.

2. "Thousand Baffles" — a labyrinth of coarse wire mesh — changes flow direction abruptly, captures remaining water and dirt.

FOR USE ON STEAM LINES TOO

HERE in one simple device you have two of the most effective principles of separation—expansion and change of direction. Its trouble-free construction and unusually high efficiency make it today's best way to remove trouble-causing water, dirt and oil from compressed air.

Team mate of the Separator is the Johnson Aftercooler, frequently installed ahead of it to condense all vaporized moisture — as shown at left. The Oil Absorber is added when every final trace of oil must be removed.

Write for bulletin containing dollar saving data on Johnson Separation Devices

The Johnson Corporation

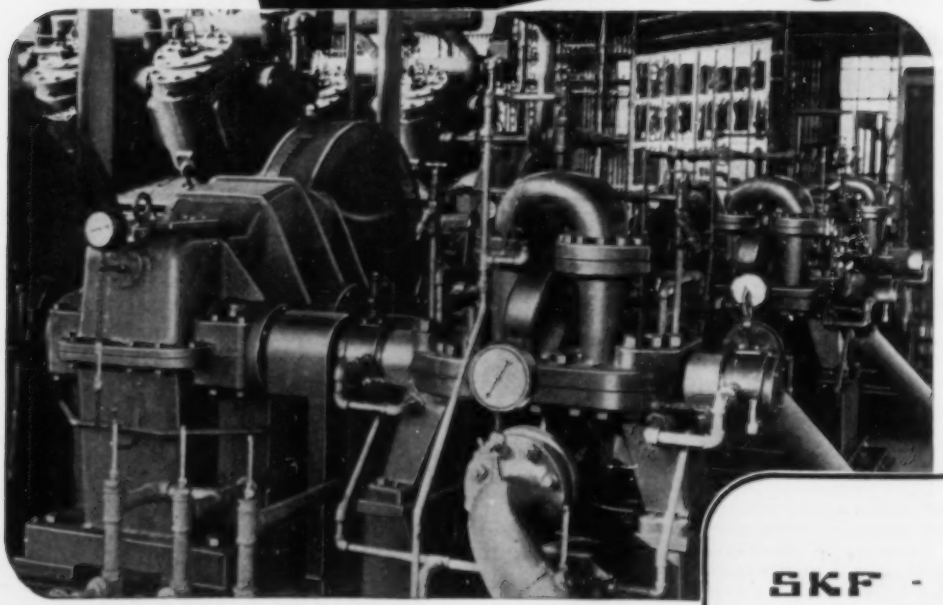
830 WOOD STREET THREE RIVERS, MICH.

CONTINUOUS *service*

ASSURED WITH SKF BEARINGS

The moment SKF Bearings started working on these Pipeline Pumps, *continuous easy running* began. That this performance record has continued every hour, every week, every month and every year since is a tribute to the reliability of SKF Bearings . . . to their ability to maintain close tolerances while absorbing radial and thrust loads . . . to the way in which they require only occasional lubrication in many years of service. In these days when Oil plays an outstanding part in the progress of the World, it is well to remember that the pump that moves it is only as good as its bearings. 5690

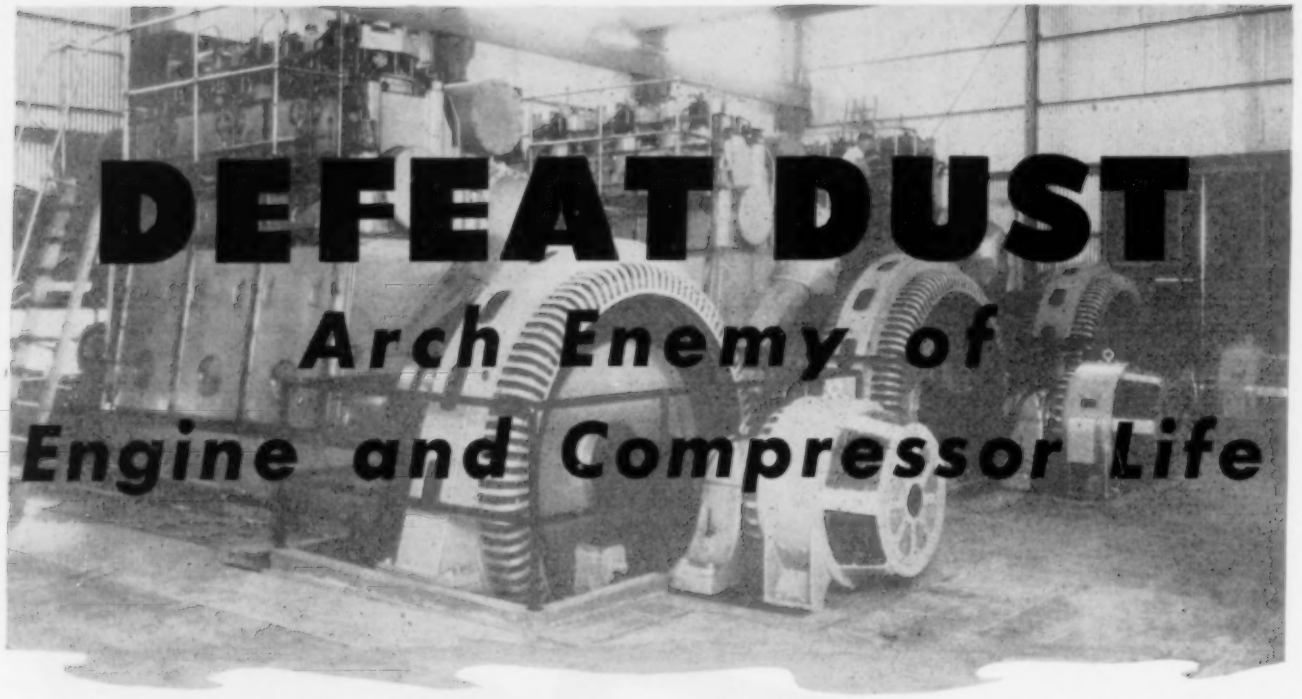
SKF INDUSTRIES, INC., PHILADELPHIA 34, PA.



SKF - EQUIPPED

Pumps

Built by Ingersoll-Rand Co.



DEFEAT DUST

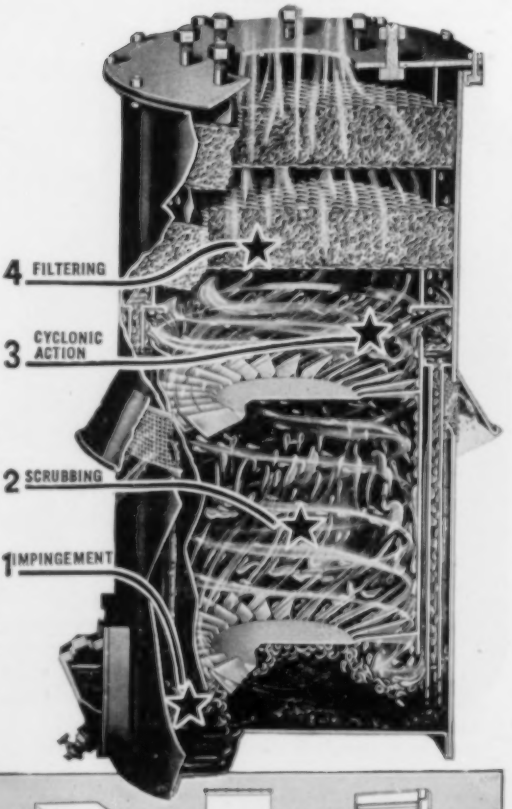
Arch Enemy of Engine and Compressor Life

WHEN you protect power equipment with AAF air cleaners you prevent the unnecessary costly, time-consuming breakdowns which always result from excessive wear caused by abrasive dust and grit that attacks the vitals of your engines and compressors.

Throughout the nation, Cycoil cleaners are prolonging the useful life of valuable power equipment—permitting uninterrupted operation on stepped-up running time and accelerated production schedules.

The cost of Cycoil's "preventive maintenance" is insignificant compared to savings in wear, running time and man-hours. Send for facts on the Cycoil and other AAF engine and compressor filters for every air and gas cleaning requirement.

THE CYCOIL OIL BATH AIR CLEANER



The fundamental advantage of the Cycoil Oil Bath cleaner is that the incoming air stream picks up an unusually large quantity of oil which is thoroughly mixed with the air (causing a scrubbing or precleaning action), and then thrown out by centrifugal action before the air stream enters the filter cell. This results in reducing the dust load on the filter cell and insuring continued self-cleaning action.

AMERICAN AIR FILTER CO. INC.
402 Central Avenue, Louisville, Kentucky
In Canada: Darling Bros., Ltd., Montreal, P. Q.

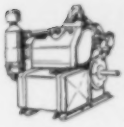
AAF

AMERICAN AIR FILTERS for ENGINES and COMPRESSORS

SUPER-FINISHED **CRANKSHAFTS**

another **"PLUS FEATURE"**

IN ALL **WISCONSIN** *Air-Cooled* **ENGINES**



The very ingenious, specially designed machine illustrated above, puts a mirror-smooth *superfinish* on the crank-pins of all Wisconsin Air-Cooled Engines. By combining perfectly synchronized rotating and oscillating polishing movements, absolutely uniform diameter is maintained over the full length of the crankshaft bearing surfaces.

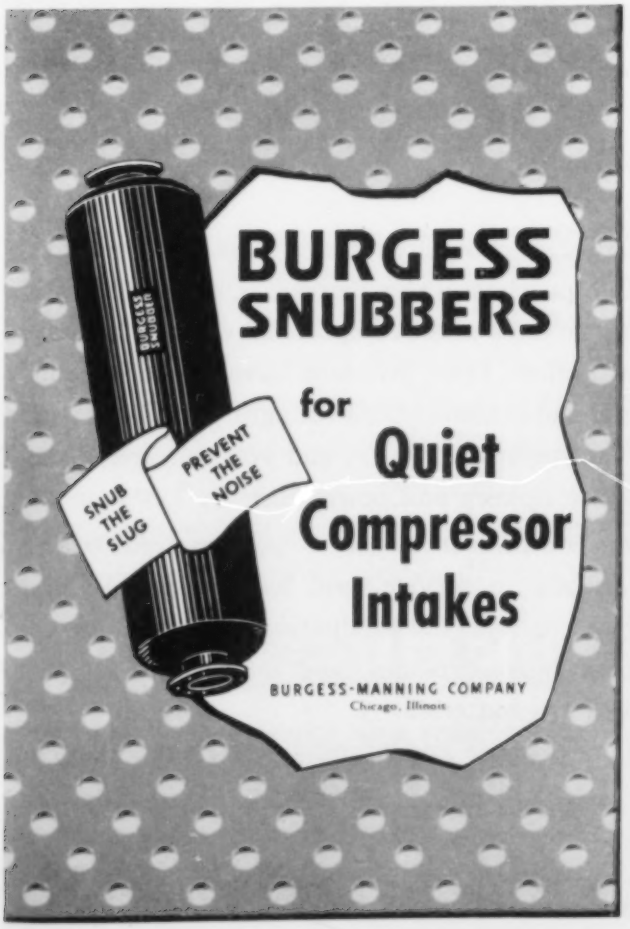
This is just another of the many small, but *important production details* that account for Wisconsin heavy-duty serviceability and smooth, efficient operation. Just another reason, too, why *your equipment* should be powered by a Wisconsin Engine.

Most H.P. per pound

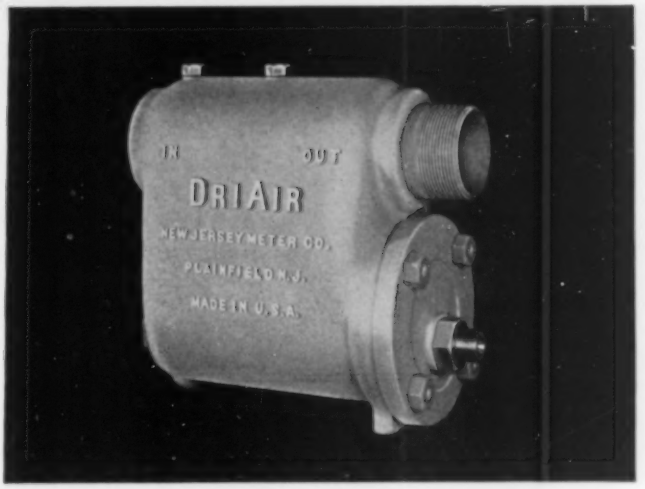
WISCONSIN MOTOR Corporation

MILWAUKEE 14, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines



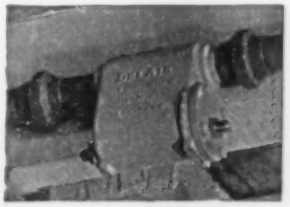
DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT



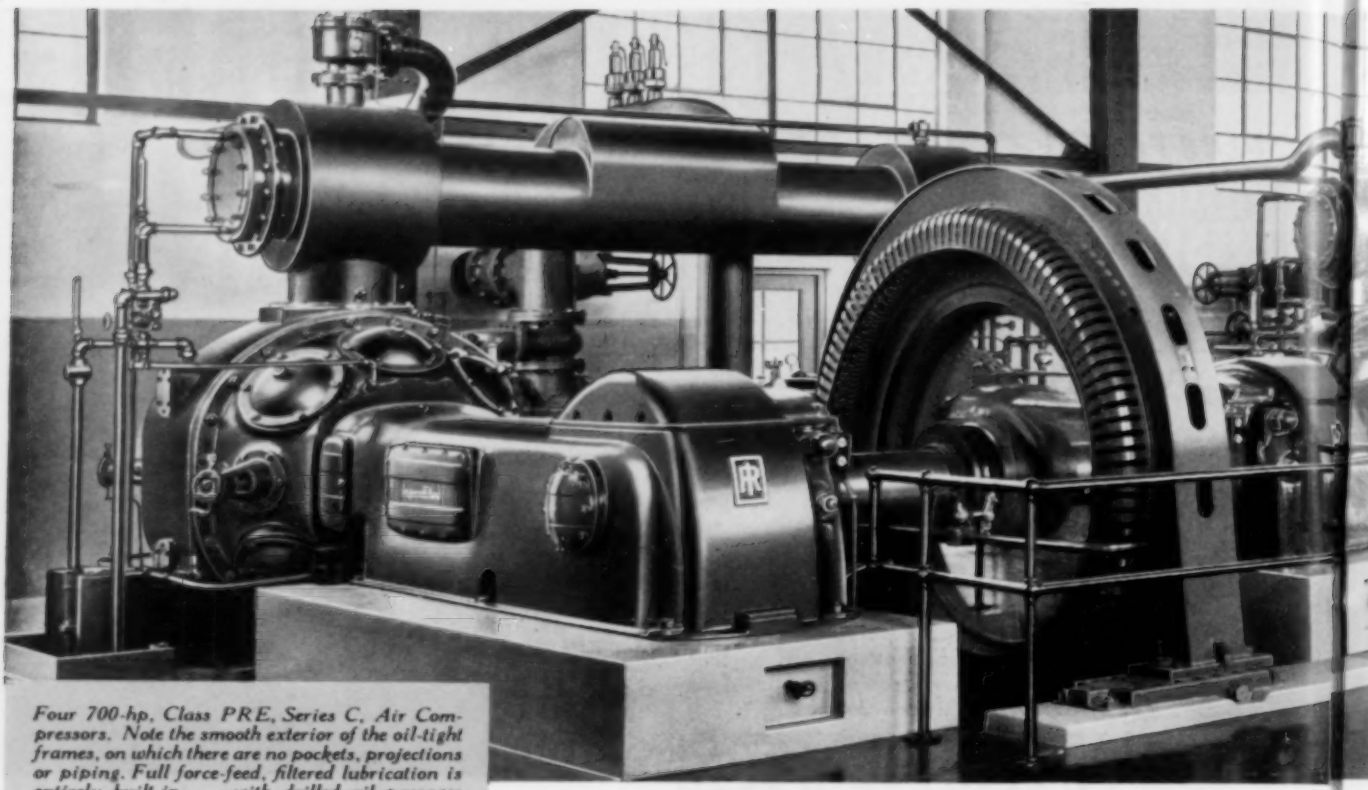
DriAir may be installed by suspending it from the piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

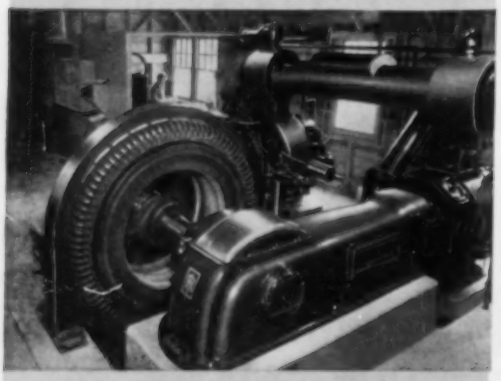
The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

NEW JERSEY METER COMPANY

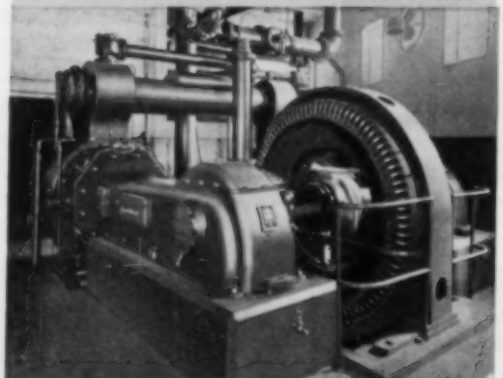
PLAINFIELD, NEW JERSEY



Four 700-hp, Class PRE, Series C, Air Compressors. Note the smooth exterior of the oil-tight frames, on which there are no pockets, projections or piping. Full force-feed, filtered lubrication is entirely built-in . . . with drilled oil passages throughout. The crankcase, which need not be opened for adjustments, stays clean. Gauges on each frame indicate main-bearing oil pressure and temperature.



A 350-hp, Class PRE two-stage Air Compressor supplying air for operating rock drills in a mine.



A 21"-stroke, Class PRE, two-stage Air Compressor in a steel plant.

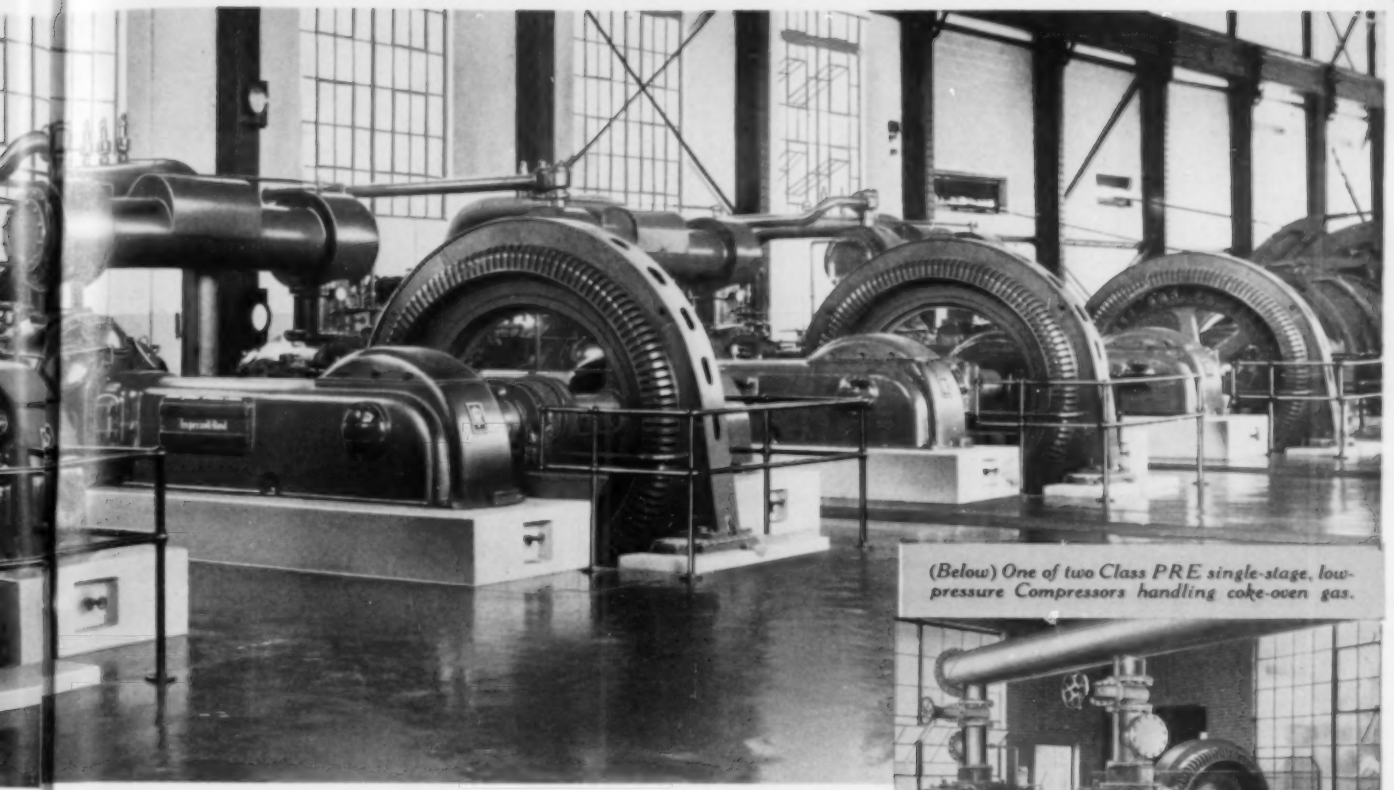
. . We hope you were Compressors

Perhaps your company was one of those permitted by WPB to purchase a new Series C, Class PRE, during the hectic days when compressors were so critical to the war effort. If so, you now have a machine that's years ahead of conventional design. You will be proud of it for years to come . . . and you will save a lot of money in upkeep and power cost.

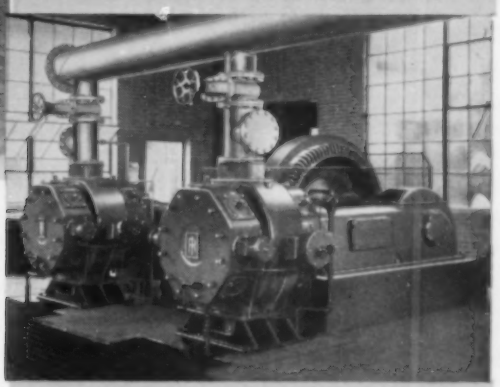
This compressor is new . . . yet hundreds of them are already in service, and have helped to make huge increases in the production of explosives, steel, rubber, ships, airplanes, and tanks—in fact, every kind of war materiel.

Its new frame and running gear represent a com-

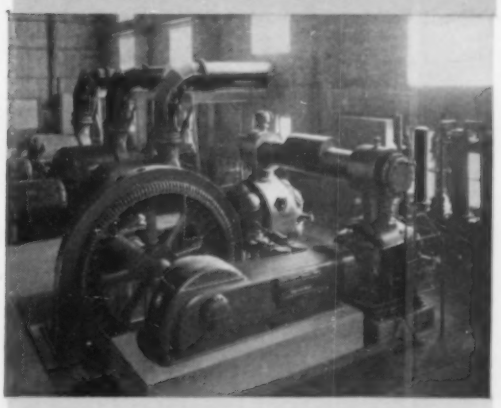
COMPRESSORS • CONDENSERS • ROCK DRILLS • AIR TOOLS



(Below) One of two Class PRE single-stage, low-pressure Compressors handling coke-oven gas.



(Below) A 3800-cfm, Class PRE Compressor furnishing air at 100-lb pressure, and three I-R Turbo-Blowers furnishing lower-pressure air for a copper mining company.



lucky enough to get like these!

plete change in construction, radically different from previous designs. Its features provide greater reliability and ease of maintenance . . . making it a machine that comes even closer to the "ideal" compressor that operators like to dream about.

If you are the owner of a new PRE, we need say no more... but if you are not, consult one of our Service Engineers who will gladly explain the many advantages of this heavy-duty electric-driven compressor.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 1-535

REMEMBER, all PRE Compressors are equipped with full, 5-step Clearance Control. This is the method of regulation that we originated, patented, and applied in 1910. It has been the standard for 34 years. We continue to use it because it is still the best method of regulating the output of large electric-driven compressors.

TURBO BLOWERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

BRING ON YOUR VIBRATION!

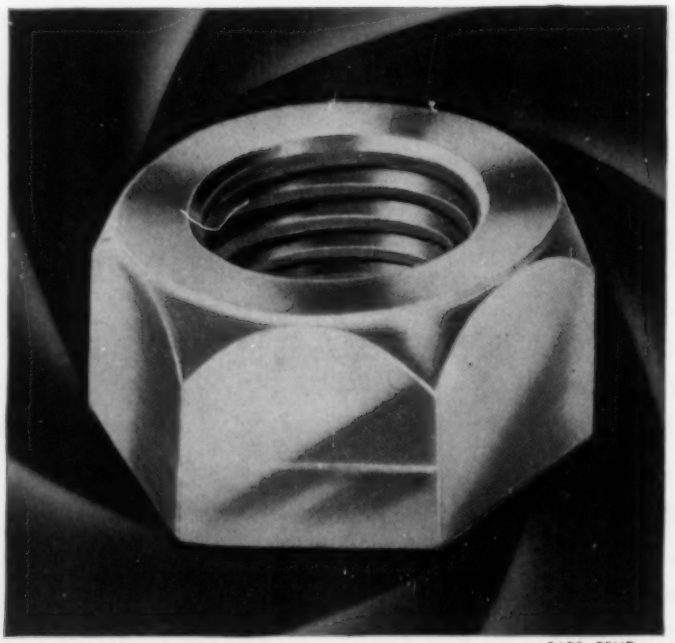
THE STOVER SELF-LOCKING NUT can "take it"!

When you have tested this *new-principle* self-locking nut, you will understand the true meaning of vibration resistance. You will see a precision-made nut which has been transformed into a powerful, metal spring. You will see the natural elasticity of metal employed to provide a mighty *grip* that defies vibration.

And yet the STOVER Self-locking Nut is a simple thing. It is in one piece with no complicated assembly. It does the whole job by itself. It locks at any point desired on the bolt and does no harm to the bolt threads. It can be used over and over without substantial loss of efficiency. It is made in standard sizes and threads from ¼ inch to 1½ inches. Finally, it costs no more than older-type less efficient lock nuts.

Send for descriptive literature and samples.

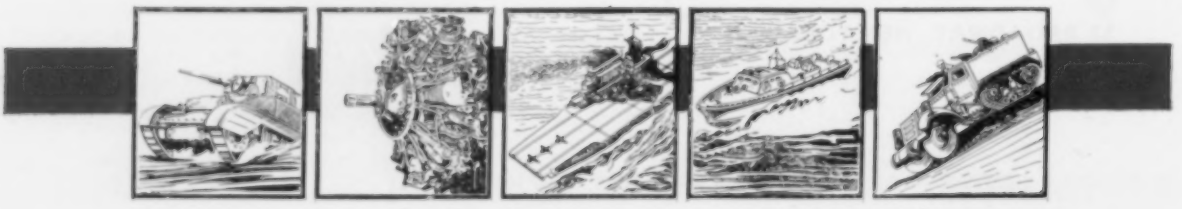
STOVER
"IT WON'T SHAKE LOOSE"



PATS. PEND.

MEETS ARMY AND NAVY SPECIFICATIONS

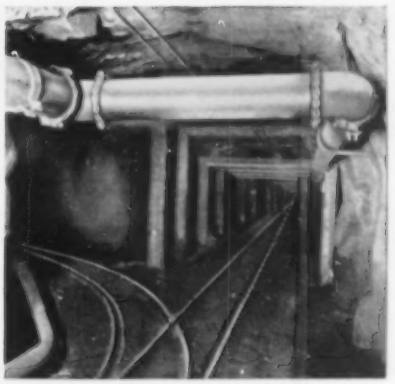
The STOVER Self-locking Nut is eliminating the loosening effect of vibration on many machines of war. Study it in relation to your postwar planning.



STOVER LOCK NUT
AND MACHINERY CORPORATION
Easton, Penna., Bushkill Drive • New York 17, N. Y., 101 Park Ave.
REPRESENTATIVES IN PRINCIPAL CITIES

1. Speedy Victaulic Couplings for Invasion Pipelines in Italy, France, the Pacific.

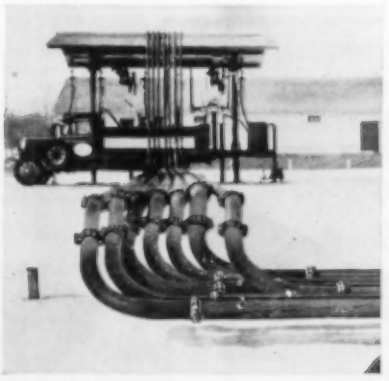
2. Flexible Victaulic Couplings for America's "bridge of ships."



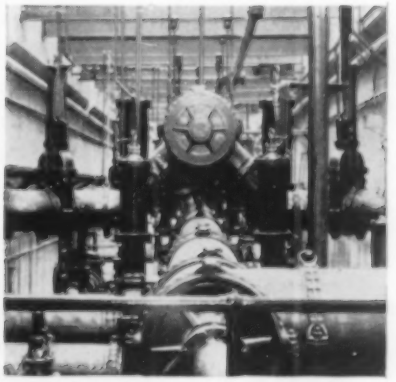
3. Self-aligning Victaulic Couplings for America's all-important mines!

A BUSY YEAR...

4. Dependable, mechanically locked Victaulic Couplings that save man-hours for America's War Industry.



5. Proven, leak-tight Victaulic Couplings continuing more than a quarter century of service for America's Oil Industry.



6. Easily installed Victaulic Couplings for America's essential Municipal Works.

A BUSY FUTURE...

The very features which have made Victaulic Couplings indispensable in War . . . make them vital in reconversion, vital to the years of peacetime business ahead. Our couplings and Victaulic Full Flow Fittings will be available from the word "GO." For detailed information write VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. *Other offices:* Victaulic Inc., 727 West 7th St., Los Angeles 14, California; Victaulic Co. of Canada, Ltd., 200 Bay Street, Toronto.

WAR BONDS
A PIPE LINE FROM YOU TO WIN

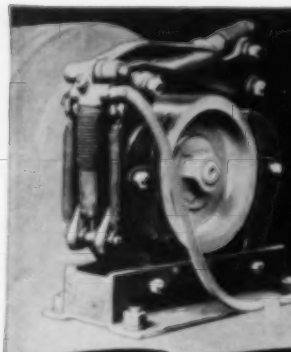
VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

Copyright 1944 by Victaulic Co. of America

OIL MINING MARINE MUNICIPAL INDUSTRIAL



Use
Wagner
HYDRAULIC INDUSTRIAL BRAKES

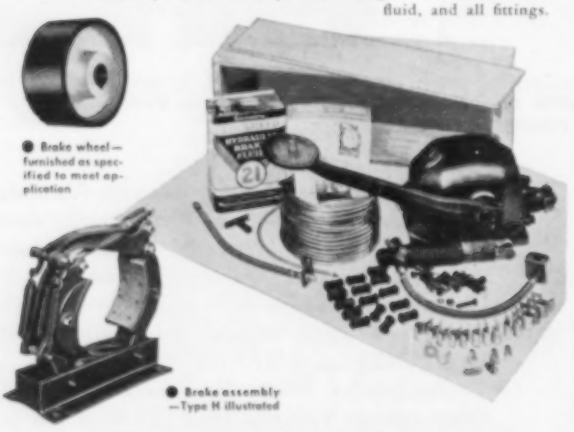
wherever industrial machinery must be stopped quickly, safely, and smoothly

While the principal application for Wagner hydraulic industrial brakes is for overhead traveling cranes, there are many other applications for which they can be efficiently used.

Some of these applications are bending rolls, scrap balers, large wheel balancers, and similiar applications when it is desirable to decelerate the machine by foot pressure for either normal or emergency stops.

Available in Complete Systems

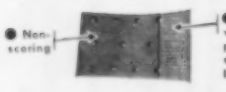
Wagner hydraulic industrial brakes come to you complete, all ready to install. The complete system includes brake assembly, brake wheel, master cylinder, wheel cylinder, tubing, flexible hose, brake fluid, and all fittings.



● Brake wheel—furnished as specified to meet application

● Brake assembly—Type H illustrated

REPLACEMENT BRAKE LINING
For any industrial brake



● Non-scoring

● Reinforced wire backing permits deep seating of bolts or rivets

Wagner molded brake lining is preformed in blocks to meet the requirements for all industrial brakes.

Send for Bulletins IU-20 *and* BU-145

I 44-7

Wagner Electric Corporation
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

WHERE WILL THE MONEY COME FROM TO MAKE HIS AMBITIONS COME TRUE?

It is America's Heartland, the rural communities and small industries, that nourish the enormous purchasing power that America must have to make our soldiers' ambitions come true. Sub-contracting to these industries will result not only in spreading purchasing power, but in providing a more efficient manufacturing procedure which makes available more and better goods to more people.

While we, of American Industry, are now putting plans into action to make the miracle of post-war production come true, let us redouble our efforts in support of War Bond Sales whose essentiality for financing the war and providing an important base for post-war purchasing power is recognized by all.

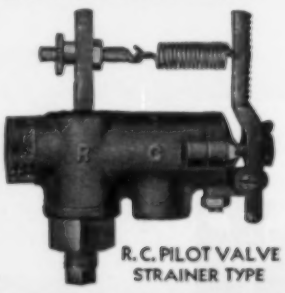
Published in the interest of War Bond Sales and a prosperous post-war America by Burgess-Norton Mfg. Co., manufacturers of piston pins, screw machine parts, and heat treated, hydrogen copper brazed and ground steel parts.

Burgess Norton
MANUFACTURING COMPANY
40 years in GENEVA, ILLINOIS

A Part is Never Made Right unless it is Satisfactory to Our Customers

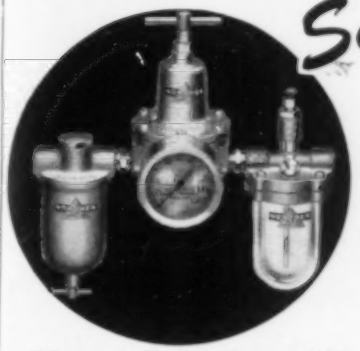
R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE
STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders



Something on the Ball

Norgren Lubro-Control Units have plenty! This compact unit—filter, regulator and lubricator—is less than a foot long. It *filters* as it *regulates* as it *lubricates*. Installs direct in air lines.

Stop choppy, chattering air tool and equipment performance. Get smooth, even full powered action. Install a Norgren! There's a size for every purpose.

Write for full information. C. A. Norgren Co., 220 Santa Fe Drive, Denver 9, Colorado.

Norgren

Speaking of Water Pump Packing . . .

Have You Tried GARLOCK 777?

This popular packing is recommended for hot or cold water service; for steam service on piston and valve rods of engines, and for steam piston rods of low pressure pumps. Quality-controlled construction assures dependable performance.

THE GARLOCK PACKING CO., PALMYRA, N.Y.
In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

Garlock

AMAZINGLY DIFFERENT BEARING BRONZE

BEARIUM METAL

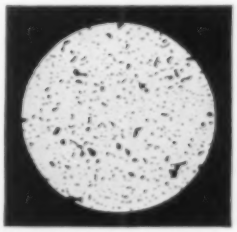
The unique structure of Bearium Metal combines not only the best features of babbitt and bronze, but, in addition, has desirable frictional characteristics that are exclusive.

★ It will not melt out like babbitt.

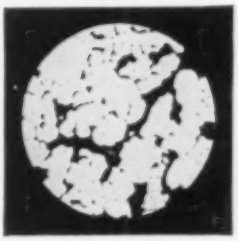
★ It does not score like an ordinary bronze.

★ It definitely puts an end to all problems ordinarily encountered in frictional applications.

Write for full information on this amazing bearing alloy.



BEARIUM METAL *magnified 25 diameters shows lead (black) in microscopic, globular form, uniformly distributed.*



ORDINARY LEADED BRONZE *at 25 diameters shows poor lead distribution, with lead between copper grains.*

BEARIUM METALS CORP.
270 State Street, Rochester 4, N. Y.

To Have and to Hold Attention–

"Pneuphonic" Air Horns are toned to a distinctive, penetrating note that commands attention. Operating on 75-140 psi, they install anywhere that compressed air is used. Sound ratings range up to 109 decibels at 100 feet.

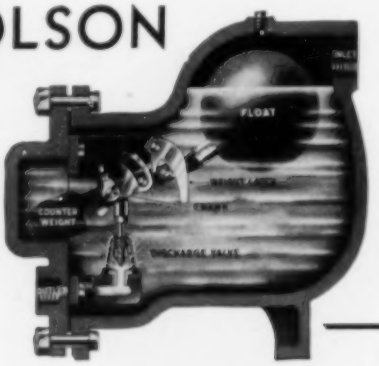
Non-directional property give them deep penetration in all directions, over large areas. This tone-carry won acceptance for widespread use as air raid warnings.

Westinghouse Air Brake Co.
Industrial Division - - - Wilmerding, Pa.

NICHOLSON

Model "JR"

TRAPS



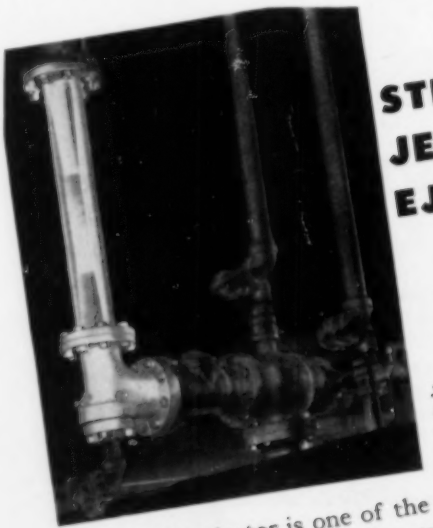
Provide

FASTER DRAINAGE

of All Air Systems

THE NICHOLSON MODEL "JR" COMPRESSED AIR TRAP, for automatically draining air separators, after-coolers, receivers, etc., is weight-operated. Therefore the valve opens wide, instantaneously, permitting full, positive drainage before it closes. Intermittent, rapid opening and closing prevents wire-drawing of the accurately ground hardened stainless steel valve and seat. Large capacity. Water-sealed discharge valve. Welded stainless steel float. Bulletin No. 341.

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties



STEAM-JET EJECTORS

Single-stage ejector serving a sterilizer unit.

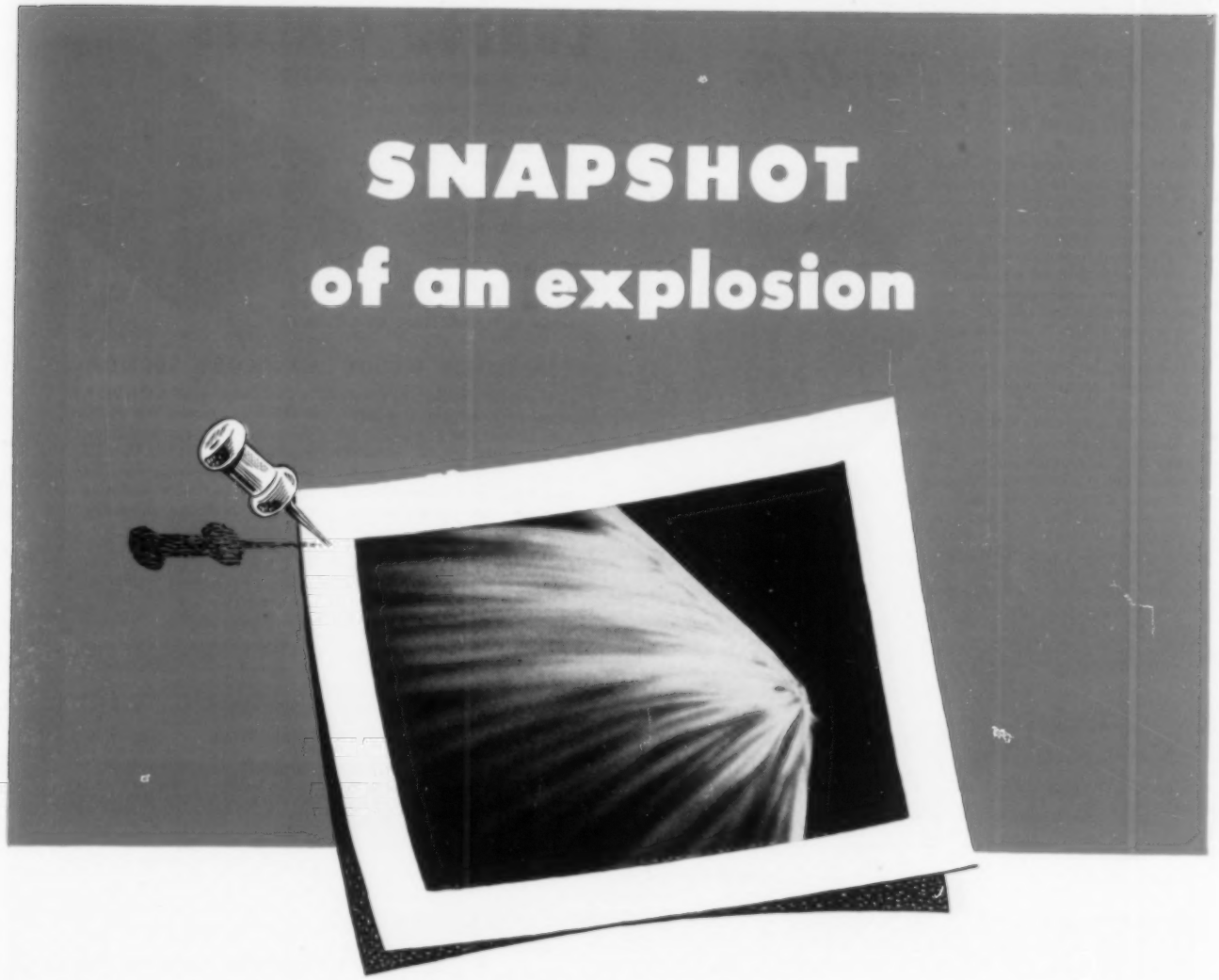
★ A steam-jet ejector is one of the simplest methods for removing air, gases and vapors from condensers and vacuum chambers. There are no moving parts.

★ Ingersoll-Rand furnishes ejectors to handle most any quantity of gas or vapor at any absolute pressure down to 50 microns Hg. Ask the I-R engineer for details.

4-286

Ingersoll-Rand
11 BROADWAY, NEW YORK CITY

SNAPSHOT of an explosion



HERE IS A STORY OF AN EXPLOSION—as told by the explosive itself. The narrow, white streak at the right is the path of detonation, flashing through the explosive at about 250 miles a minute! The feathery haze is a photographic record of white-hot gases bursting outward at tremendous pressures as high as a million pounds to the square inch.

Facts such as these are recorded, studied, and analyzed by Hercules scientists. Each day scores of research projects are carried on to broaden the knowledge and understanding of explosives. It is through constant, intelligent research that we endeavor to help you and thus benefit ourselves.

HERCULES EXPLOSIVES

HERCULES POWDER COMPANY
INCORPORATED
932 King Street
Wilmington 99 . . . . . Delaware

New Model A-1 *Pur-O-fier*

For Compressed Air

Positive purification of air lines is assured with this new Model A-1 Pur-O-fier designed to eliminate free moisture, oil and foreign matter in small compressed air systems. It operates with from 1 to 5 cubic feet of air and for intermittent operations is extremely sensitive to the slightest movement of air. Weighing only 1¼ lbs., this new unit is just 3⅛" in diameter by 5 9/16" deep including plastic, transparent entrainment sump. Model A-1 Pur-O-fier requires no maintenance.

Drain valve permits easy and quick draining of the sump. Pur-O-fier uses positive, centrifugal action as a medium for purification and can be used for air-operated instrument controls, air-operated gauges of the precision and checking type, and air-operated cleaning devices of many types. This unit will operate effectively from 1 to 75 P.S.I. Write for bulletin No. 11 giving complete details.

Patent applied for

Write for New Bulletin No. 11 giving complete specifications and applications

BIRD-WHITE COMPANY
3120 WEST LAKE STREET
CHICAGO, ILLINOIS

CONDOR V-BELTS

Now made with FLEXLASTICS*

FLEXLASTICS*—elastic materials used in combination with Strength Members make CONDOR V-BELTS with highest degree of *flexibility, efficiency and lasting service.*

CORD

Strands of strong, pre-stretched cords made to MANHATTAN specifications.

COMPRESSION SECTION

... tough, firm FLEXLASTICS compression section, furnishes side-wall contact. FLEXLASTICS in body resists fatigue, reduces internal friction. Body is wrapped with closely woven fabric to resist wear, yet permit *easy flexing.*

WHIPCORD SECTION

... backbone of CONDOR V-BELTS ... carries the load. Imbedded in strong, tenacious, heat-dissipating FLEXLASTICS to produce a homogeneous, inseparable unit with maximum strength, flexibility, durability and *extreme lack of stretch.*

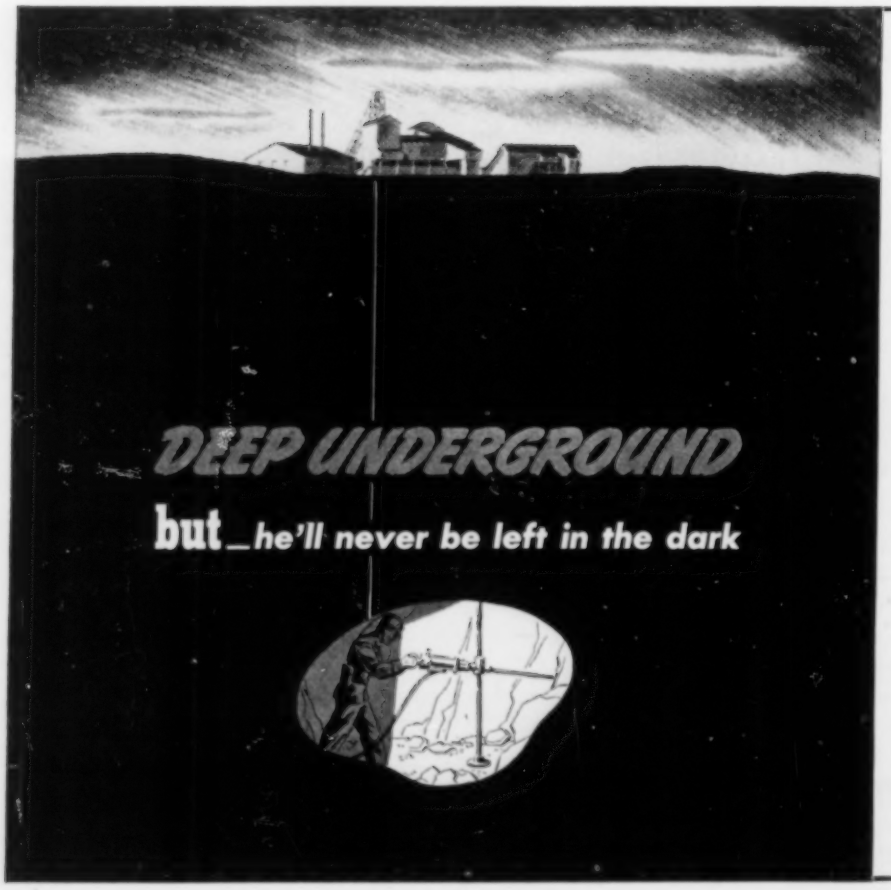
8 POINTS of BALANCE

1. Wide margin of strength
2. Minimum inelastic stretch
3. Uniform flexibility
4. Maximum resistance to structural breakdown
5. Smooth running
6. Maximum traction
7. High resistance to side wear
8. Correct lateral reinforcement

**The term FLEXLASTICS is an exclusive MANHATTAN trade mark. Only MANHATTAN can make FLEXLASTICS.*

KEEP AHEAD WITH MANHATTAN 52nd Year

THE MANHATTAN RUBBER MFG. DIVISION
OF RAYBESTOS-MANHATTAN, INC.
Executive Offices Passaic, New Jersey



KEEPING faith with the miner in his fight for production victory is the steadfast dependability of the Edison Electric Cap Lamp. Furnishing more effective light, in greater volume, for greater daily tonnage, the Edison Lamp is engineered and built for continuous trouble-free service—to the last specification and the last ounce of material.

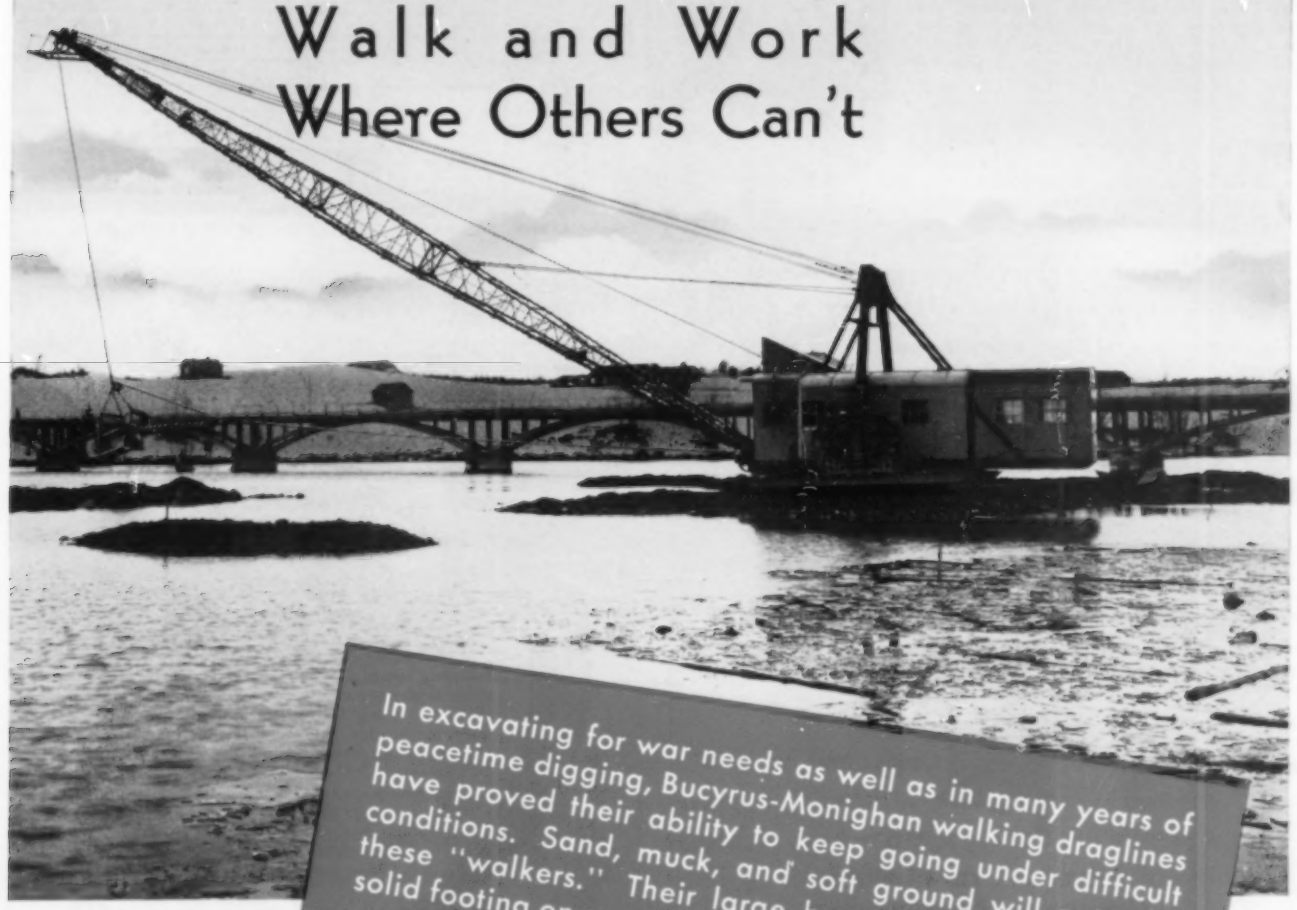
Better light makes better miners—and the Edison Lamp lives up to its responsibility of providing better light throughout every shift. Armed with the Edison Lamp and its sturdy companion, M. S. A. Skullgard, today's miner is well-protected against underground hazards—while doing an essential job for America.

MINE SAFETY APPLIANCES CO.
Braddock, Thomas and Meade Streets
PITTSBURGH, PENNA.

District Representatives in Principal Cities

BUCYRUS-MONIGHANS

Walk and Work Where Others Can't



In excavating for war needs as well as in many years of peacetime digging, Bucyrus-Monighan walking draglines have proved their ability to keep going under difficult conditions. Sand, muck, and soft ground will not stop these "walkers." Their large bearing areas give them solid footing on ground too soft for other machines. Their easy maneuverability and smooth walking traction permit them to step around trouble. Their simple construction keeps maintenance low and allows them to deliver steady performance.

Add to these features the high output for which Bucyrus - Monighans are famous and you have a big reason for including these field-proved machines in your excavating equipment. Plan now to take advantage of Bucyrus-Monighan ability to help solve your excavating problems fast and efficiently.

G-49

AVAILABLE with BOOMS 80 ft. to 250 ft. BUCKETS 3 to 25 Cu. Yds.

BUCYRUS MONIGHAN

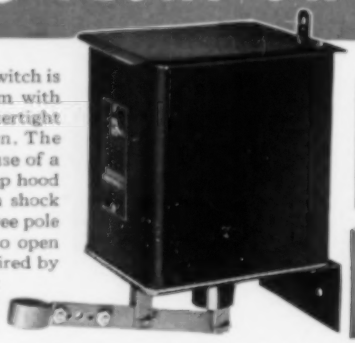
SOLD BY

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

Marine FLOAT SWITCH

DRIPPROOF AND WATERTIGHT
HIGH SHOCK CONTACT BLOCK
TWO OR THREE POLE
CLASS 9036 • TYPE AW-H



● The class 9036 type AW-H float switch is built for Marine Service to conform with requirements for a dripproof and watertight device of shockproof construction. The switch differs from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block of two or three pole form. The switch can be arranged to open or close on rise in liquid level as required by application. Mounting is three point by means of bracket flange and foot, as illustrated. **Write for Bulletin 563.**

ELECTRICAL RATINGS

Voltage	Single Phase A. C.	Polyphase A. C.	D. C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	.....
32V.	.....	.....	½ H.P.

REGULATOR DIVISION
SQUARE D COMPANY
DETROIT • MICHIGAN

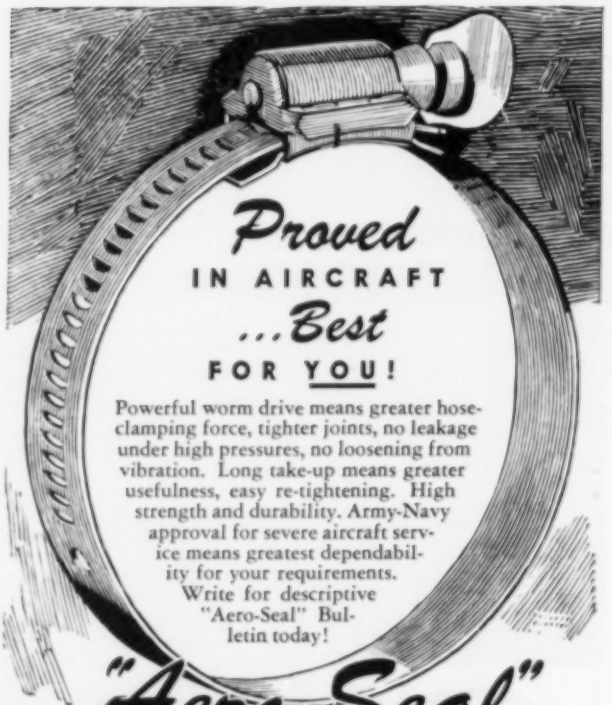
There Is No Compressed Air Condition So Bad In Any Factory That We Cannot Correct and Completely Remedy

WATER removed from AIRLINES AUTOMATICALLY with the MURPHY SEPARATOR

SIZES ½" TO 4" PIPE
Literature and Prices on request

RESULTS - - - GUARANTEED
NO ABSORBENTS - NO CHEMICALS
AFTERCOOLERS - - - SPRAYERS

JAS. A. MURPHY & CO.
HAMILTON, OHIO



Proved
IN AIRCRAFT
...Best
FOR YOU!

Powerful worm drive means greater hose-clamping force, tighter joints, no leakage under high pressures, no loosening from vibration. Long take-up means greater usefulness, easy re-tightening. High strength and durability. Army-Navy approval for severe aircraft service means greatest dependability for your requirements. Write for descriptive "Aero-Seal" Bulletin today!

"Aero-Seal" HOSE CLAMPS

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OPEN HEARTH & ELECTRIC STEEL
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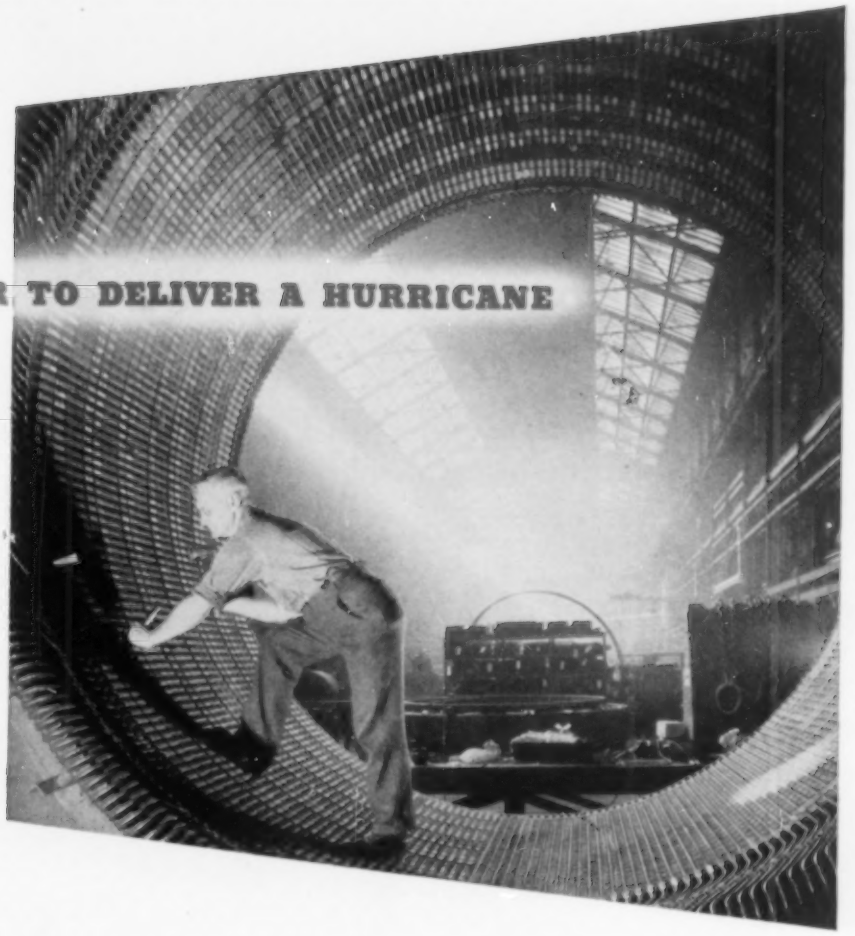
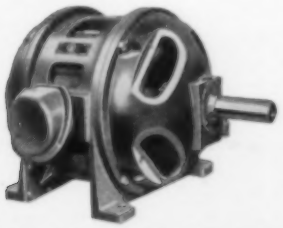
BUILDING A MOTOR TO DELIVER A HURRICANE



Driving a 400 mile-an-hour super-hurricane through a plane-testing tunnel takes plenty of horsepower . . . more than anybody had ever packed into a wound-rotor induction motor before. To do it, Westinghouse designed and built the world's largest. Its 40,000 horsepower spins two 16-blade fans standing nearly 40 feet high—weighing 197 tons. The motor itself weighs 125 tons, stands 15 feet high and you could drive a small truck through the stator you see above. Cooling it takes 85,000 cubic feet of air per minute.

This is just another example of Westinghouse ability to build motors—motors designed to do specific jobs. It's the kind of engineering skill back of every Westinghouse motor you buy—special or standard.

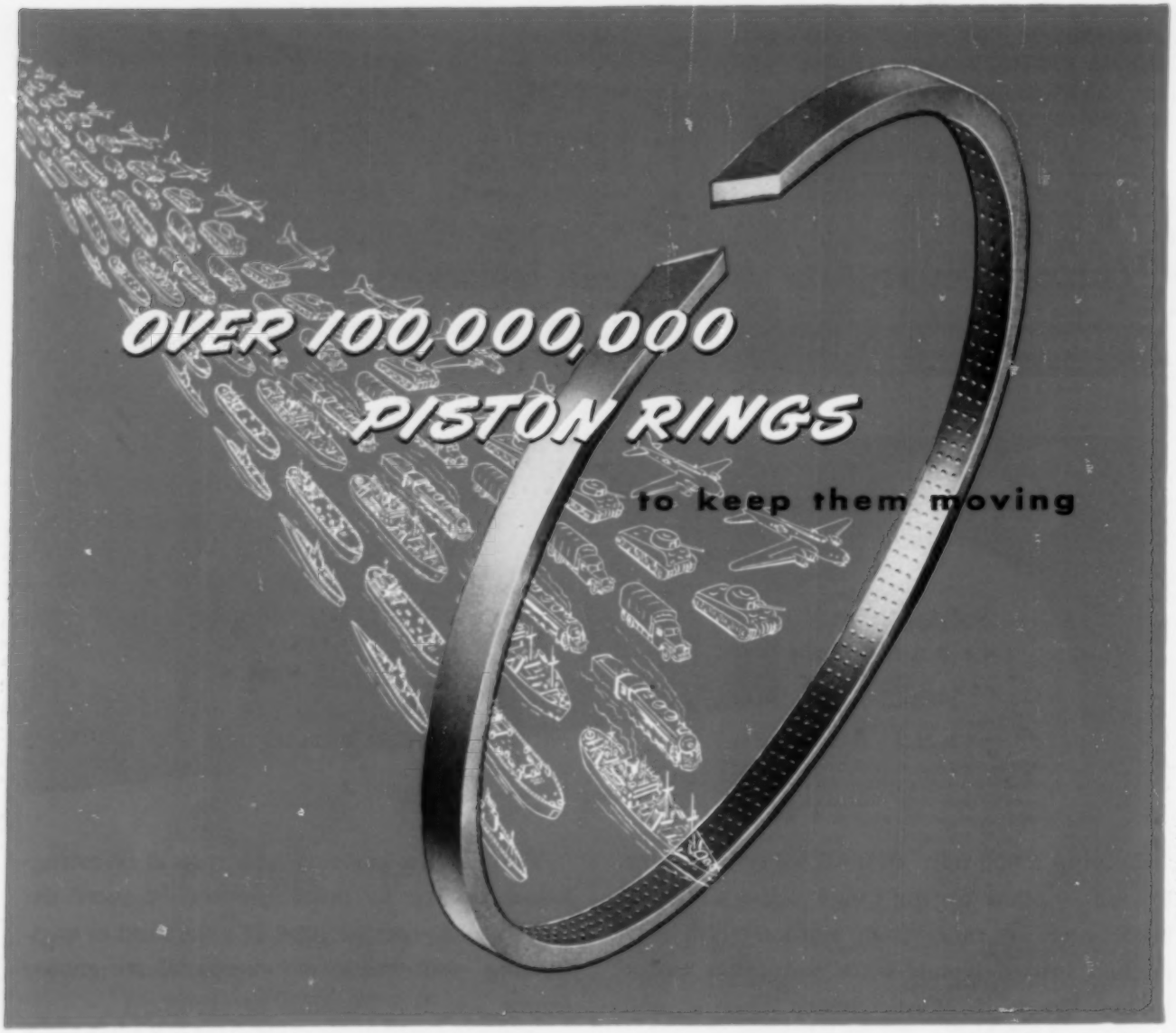
For war work or postwar reconversion, take full advantage of this ready-to-use experience. You'll solve your drive problem quicker and know the motor will fit the job—whether it is a fractional or 40,000 horsepower. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. J-21294



This is only one of the many Westinghouse general purpose motors available in standard and special enclosures. Features include choice of sealed sleeve or ball bearings; Tuffernell insulation; Balanced rotor; rigid one-piece frame; die-cast rotor; radio-frequency tested insulation.

Westinghouse Motors

PLANTS IN 25 CITIES ... OFFICES EVERYWHERE



Production figures on mobile equipment for the armed forces make everyone gasp . . . but multiply them by 100, and you'll have a rough idea of *ring* requirements. Subs, ships, locomotives, trucks, tanks and planes, all must have rings before they can move. A 4-motored bomber carries almost 1000 rings, with other thousands waiting in reserve.

Over 100,000,000 American Hammered Piston Rings have been produced to meet these needs, in sizes that would fit a baby's finger up to giants you could drive a horse and buggy through. Placed in one pile, these rings would tower over 200 miles into the sky. Edge to edge, they would make a chain that would girdle the earth at the Arctic circle. And in many, tolerances on certain finishes are *two millionths of an inch.*

Our engineers still found time for *new* developments that have revolutionized ring standards: the PORUS-KROME* treatment that has doubled and redoubled life in the most punishing service, and alloys that double tensile strength, and so increase engine performance.

Over 30,000 foundry patterns back up American Hammered's slogan: "Piston Rings of every type—in every size—for every purpose." Koppers Co., Inc., American Hammered Piston Ring Division, Baltimore, Md.

* Van der Horst Process

The first Army-Navy "E" awarded exclusively for piston ring production.

Buy MORE War Bonds—and keep them!

The "Facts of Life" for wire rope users . . .

EVEN when you start with a good wire rope—such as American TIGER BRAND—treat it right if you want it to give all the life that is built into it.

In this handy 48-page booklet are the things every wire rope user should know about proper rope handling and care.

The easy-to-follow instructions and the practical suggestions it offers are based on the experience of thousands of rope users. They will help you avoid the common errors that shorten rope life and reduce operating efficiency.

Subjects covered include — correct handling of ropes, how and when to lubricate, attaching of clips and sockets, splicing, care of sheaves and drums, minimum safety factors and many other helpful hints that will show you how to keep your wire rope operating at maximum efficiency and for the longest possible time.

Right now, with seasoned operators few and far between, this handy guide to better rope performance is doubly valuable. This booklet is free. Send for as many copies as you need and get them into the hands of the right men.

Send for FREE WALL CHART, too

The ten vital rules of wire rope care and handling are graphically illustrated and briefly described in this attractive wall chart. Printed in colors, on a 15" x 21" heavy cardboard mount, it can be placed for ready reference wherever wire rope is being used. Acts as a constant reminder of good wire rope operating use and practice.

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Carries 80,000 *Pounds*

ON TIMKEN BEARINGS

Bigger payloads will cut hauling time and costs. That was the thinking back of the development of this Easton Model TR-15T Trailer or Trackless Mine Car.

With a gross weight, (including hauling unit) of 125,000 lbs. and a maximum payload of 80,000 lbs., this tremendous vehicle represents a new ceiling in haulage capacity in the metal mining and quarrying industries, for which it primarily is intended.

To sustain and move the terrific loads the trailer is built to handle, 8 full-floating wheels are used, and to assure freedom from friction; maximum lateral stability; and complete protection against radial, thrust and combined loads, all these wheels are mounted on Timken Tapered Roller Bearings.

The Easton Car & Construction Company has had a lot of experience with Timken Bearings; knows they can be depended upon to keep wheels and shafts turning smoothly, reduce power demands, increase endurance, cut maintenance —and so do users of Easton equipment. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

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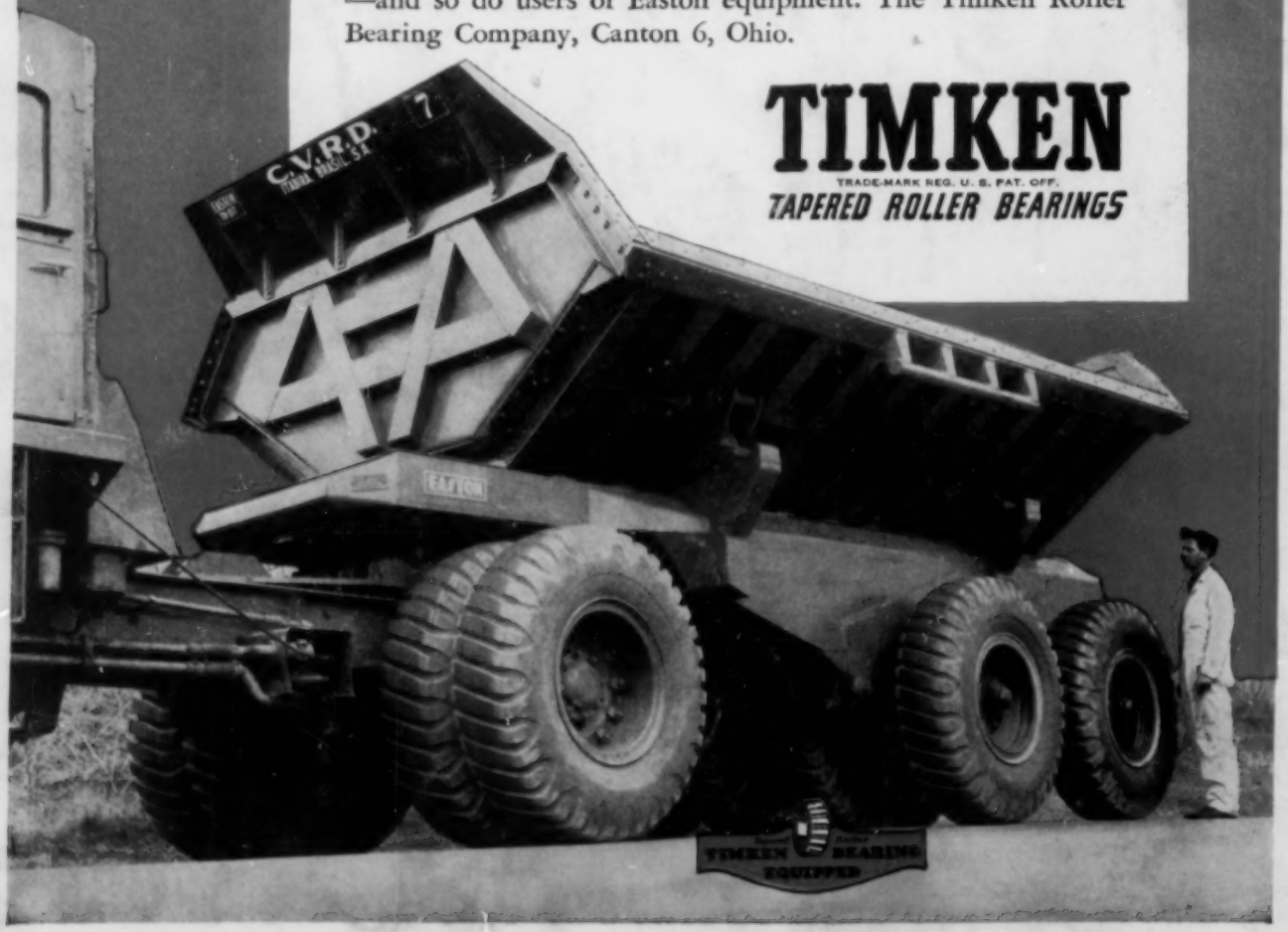
TAPERED ROLLER BEARINGS